

***EPA APPROVED***

**TOTAL MAXIMUM DAILY LOAD (TMDL)**

**FOR**

**GALISTEO CREEK**



**AUGUST 22, 2017**

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*For Additional Information please visit:*

[www.env.nm.gov/swqb/index.html](http://www.env.nm.gov/swqb/index.html)

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**Cover photo: Galisteo River at Cerrillos, New Mexico, April 27, 2010. Photo credit: SWQB staff.**

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## LIST OF ABBREVIATIONS

|                     |  |
|---------------------|--|
| 4Q3                 | 4-Day, 3-year low-flow frequency   |
| 6T3                 | Temperature not to be exceeded for 6 or more consecutive hours on more than 3 consecutive days |
| AU                  | Assessment Unit  |
| BMP                 | Best management practices  |
| CFR                 | Code of Federal Regulations  |
| cfs                 | Cubic feet per second  |
| cfu                 | Colony forming units   |
| CGP                 | Construction general storm water permit  |
| CoolWAL             | Cool Water Aquatic Life  |
| CWA                 | Clean Water Act  |
| CWAL                | Cold Water Aquatic Life  |
| °C                  | Degrees Celsius  |
| °F                  | Degrees Fahrenheit   |
| HUC                 | Hydrologic unit code   |
| j/m <sup>2</sup> /s | Joules per square meter per second   |
| km <sup>2</sup>     | Square kilometers  |
| LA                  | Load allocation  |
| lbs/day             | Pounds per day   |
| mgd                 | Million gallons per day  |
| mg/L                | Milligrams per Liter   |
| mi <sup>2</sup>     | Square miles   |
| mL                  | Milliliters  |
| MCWAL               | Marginal Coldwater Aquatic Life  |
| MOS                 | Margin of safety   |
| MOU                 | Memorandum of Understanding  |
| MS4                 | Municipal separate storm sewer system  |
| MSGP                | Multi-sector general storm water permit  |
| NM                  | New Mexico   |
| NMAC                | New Mexico Administrative Code   |
| NMED                | New Mexico Environment Department  |
| NPDES               | National Pollutant Discharge Elimination System  |
| NPS                 | Nonpoint source  |
| QAPP                | Quality Assurance Project Plan   |
| RFP                 | Request for proposal   |
| SEE                 | Standard Error of the Estimate   |
| SLO                 | State Land Office  |
| SSTEMP              | Stream Segment Temperature Model   |
| SWPPP               | Storm water pollution prevention plan  |
| SWQB                | Surface Water Quality Bureau   |
| TMDL                | Total Maximum Daily Load   |
| UAA                 | Use Attainability Analysis   |
| USEPA               | U.S. Environmental Protection Agency   |
| USFS                | U.S. Forest Service  |
| USGS                | U.S. Geological Survey   |
| WBP                 | Watershed-based plan   |
| WLA                 | Waste load allocation  |
| WQCC                | Water Quality Control Commission   |
| WQS                 | Water quality standards (20.6.4 NMAC as amended through March 2, 2017)                         |

## EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act, 33 U.S.C. §1313<sup>1</sup>, requires states to develop Total Maximum Daily Load (TMDL) management plans for water bodies determined to be water quality limited. A TMDL is defined as “*a written plan and analysis established to ensure that a waterbody will attain and maintain water quality standards including consideration of existing pollutant loads and reasonably foreseeable increases in pollutant loads*” (USEPA, 1999). A TMDL defines the amount of a pollutant a waterbody can assimilate without violating a state’s water quality standards. It also allocates that load capacity to known point sources and nonpoint sources at a given flow. It further identifies potential methods, actions, or limitations that could be implemented to achieve water quality standards. TMDLs are defined in 40 Code of Federal Regulations Part 130 (40 C.F.R. §130.2(i)<sup>2</sup>) as the sum of the individual Waste Load Allocations (WLAs) for point sources and Load Allocations (LAs) for nonpoint source and background conditions. They also include a Margin of Safety (MOS) in acknowledgement of various sources of uncertainty in the analysis.

Temperature was first listed as a cause of aquatic life use (ALU) non-support for Galisteo Creek in 2004. A Use Attainability Analysis<sup>3</sup> (UAA) for temperature criteria of ALU designations was completed in 2013. As a result of the UAA, the creek was divided into two Assessment Units (AUs). The New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) conducted a water quality survey of the Middle Rio Grande and its tributaries in 2014. Water quality monitoring stations were located within the Galisteo Creek watershed to evaluate the impact of tributary streams and ambient water quality conditions. Assessment of data generated during this monitoring effort confirmed temperature impairments in both the downstream and the upstream Assessment Units. This TMDL document addresses the above noted impairments as summarized in the Tables ES-1 and ES-2, below. Additional information regarding these impairments can be reviewed in the current Clean Water Act §303(d)/ §305(b) Integrated Report and List (IR)<sup>4</sup>. SWQB has not previously prepared any other TMDL documents for Galisteo Creek.

The next scheduled water quality monitoring date for the Middle Rio Grande and its tributaries is 2023-24, at which time TMDL targets will be re-examined and potentially revised, as this document is considered to be an evolving management plan. In the event that new data indicate that the targets used in this analysis are not appropriate and/or if new standards are adopted, the load capacity will be adjusted accordingly. When water quality standards have been achieved, the reach will be moved to the appropriate category in the IR.

<sup>1</sup> <http://www.epw.senate.gov/water.pdf>

<sup>2</sup> <http://www.gpo.gov/fdsys/pkg/CFR-2002-title40-vol18/pdf/CFR-2002-title40-vol18-part130.pdf>

<sup>3</sup> <https://www.env.nm.gov/swqb/UAA/Galisteo/22-UAA-Galisteo.pdf>

<sup>4</sup> <https://www.env.nm.gov/swqb/303d-305b/>

**Table ES-1. Total Maximum Daily Load for Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)**

|                              |  |
|------------------------------|--|
| New Mexico Standards Segment | 20.6.4.121   |
| Waterbody Identifier         | NM-2118.A_12   |
| Segment Length               | 10.0 miles   |
| Parameters of Concern        | temperature  |
| Uses Affected                | High Quality Coldwater Aquatic Life  |
| Geographic Location          | Rio Grande – Santa Fe USGS Hydrologic Unit Code 13020201   |
| Scope/size of Watershed      | 32.3 mi <sup>2</sup>   |
| Land Type                    | Southern Rockies (Ecoregion 21d)   |
| Land Use/Cover               | 42% grassland, 35% scrub/shrub, 21% evergreen forest, 1% developed   |
| Probable Sources             | Highway/road/bridge runoff; stream channel incision; logging (legacy); abandoned mines/tailings; rangeland grazing; bridges/culverts/RR crossing; low water crossing; gravel or dirt roads |
| Land Management              | 77% private, 9% Forest Service, 7% tribal, 6% State, 2% Bureau of Land Management  |
| IR Category                  | 5/5B   |
| Priority Ranking             | High   |
| TMDL for:                    | WLA + LA + MOS = TMDL  |
| Temperature                  | 0 + 53.21 + 6.26 = 59.47 J/m <sup>2</sup> /s/day   |

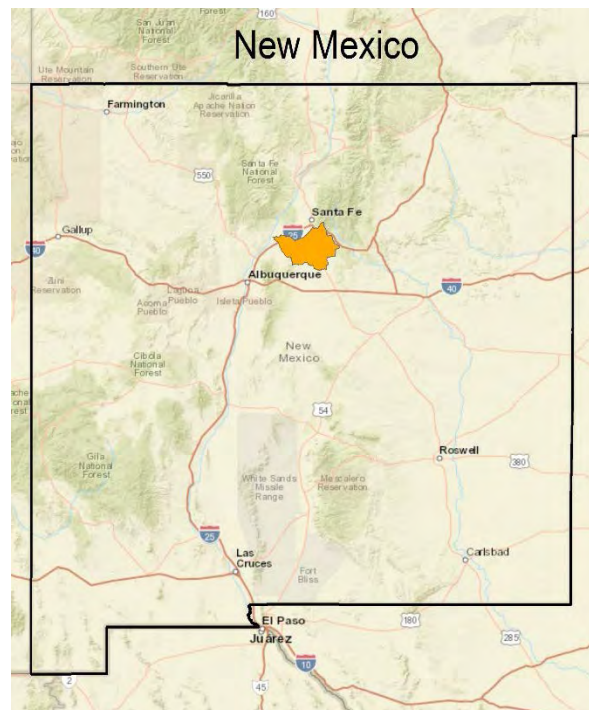
**Table ES-2. Total Maximum Daily Load for Galisteo creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy)**

|                              |   |
|------------------------------|---|
| New Mexico Standards Segment | 20.6.4.139  |
| Waterbody Identifier         | NM-2118.A_10  |
| Segment Length               | 33.5 miles  |
| Parameters of Concern        | temperature   |
| Uses Affected                | Coolwater Aquatic Life  |
| Geographic Location          | Rio Grande – Santa Fe USGS Hydrologic Unit Code 13020201  |
| Scope/size of Watershed      | 670 mi <sup>2</sup>   |
| Land Type                    | Arizona/New Mexico Plateau (Ecoregion 22h)  |
| Land Use/Cover               | 42% grassland, 35% scrub/shrub, 21% evergreen forest, 1% developed  |
| Probable Sources             | Highway/road/bridge runoff; residences/buildings; channelization; dams/diversions; stream channel incision; bridges/culverts/RR crossing; gravel or dirt roads; low water crossing; rangeland grazing |
| Land Management              | 77% private, 9% Forest Service, 7% tribal, 6% State, 2% Bureau of Land Management   |
| IR Category                  | 5/5C  |
| Priority Ranking             | High  |
| TMDL for:                    | WLA + LA + MOS = TMDL   |
| Temperature                  | 0 + 183.89 + 20.72 = 204.61 J/m <sup>2</sup> /s/day   |

## 1.0 BACKGROUND

### 1.1 Watershed Description

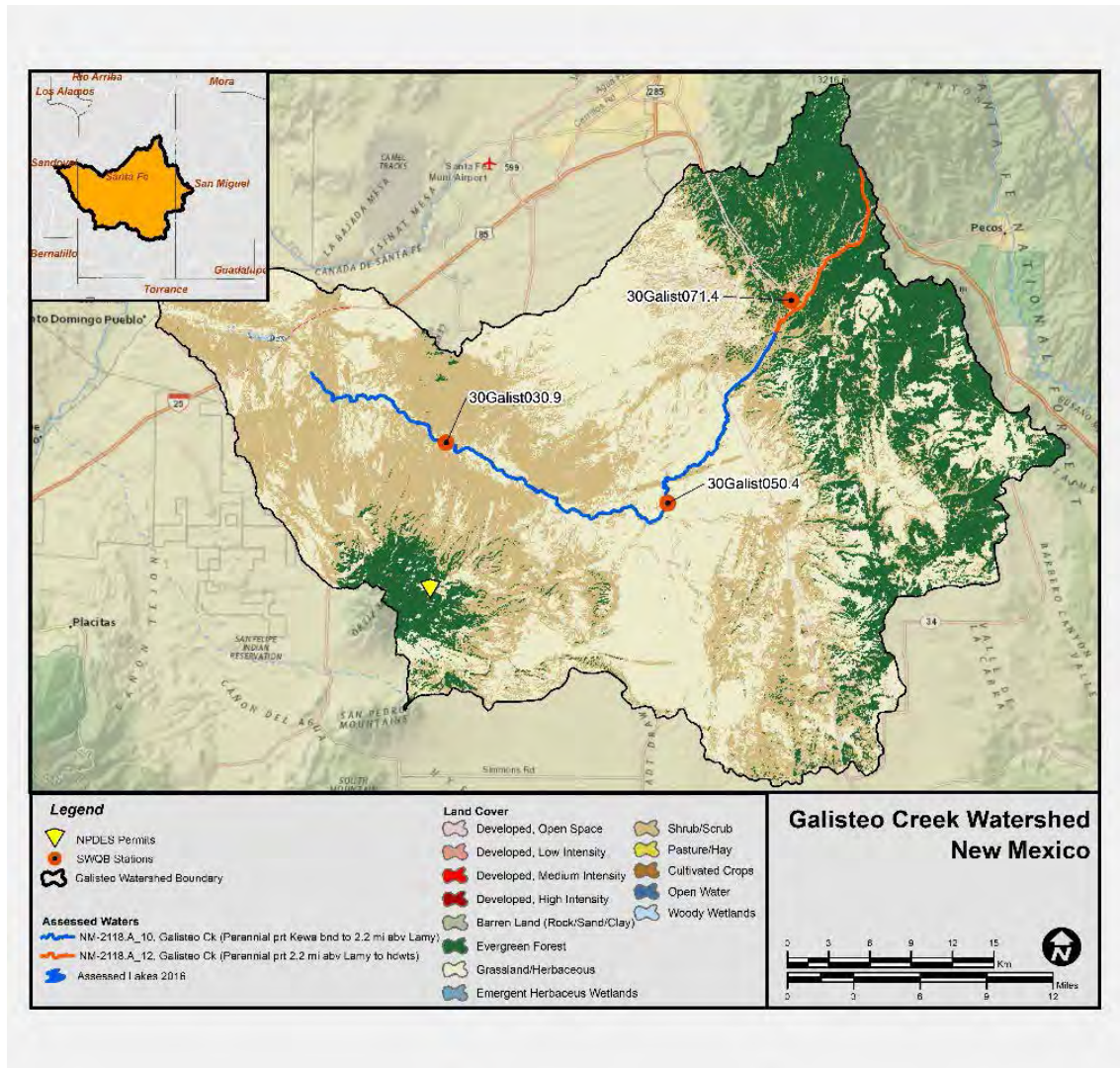
Galisteo Creek, in north central New Mexico, is part of the USGS Rio Grande-Santa Fe hydrologic unit (HUC 13020201). Most of the watershed lies in Santa Fe County; the extreme eastern edge extends into San Miguel County and the confluence with the Rio Grande occurs in Sandoval County, on lands of the Kewa (formerly Santo Domingo) Pueblo (waters on tribal lands are not Waters of the State). Stream flows vary throughout the length of the stream and may be perennial, intermittent or ephemeral.



**Figure 1.1. Location of the Galisteo Creek watershed in New Mexico.**

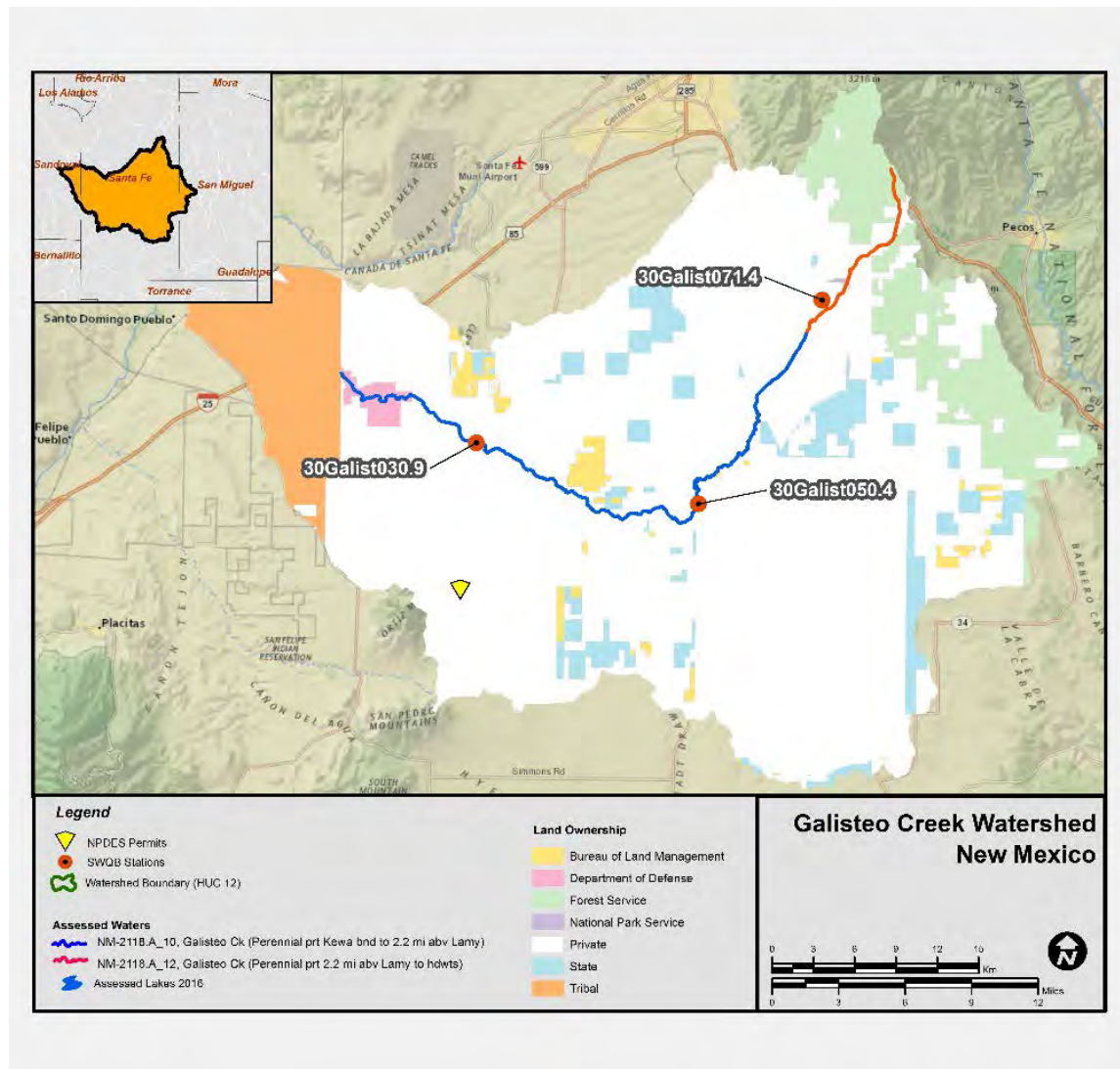
The Galisteo watershed has been settled for centuries, and impacted by many land and water uses. Current watershed land cover includes 42% grassland, 35% scrub/shrub, 21% evergreen forest, and 1% developed (Figure 1.2). Mean annual precipitation at Santa Fe, the nearest town for which data is available, is 14.2 inches (<http://www.usclimatedata.com/climate/santa-fe/new-mexico/united-states/usnm0292>, accessed 3/22/17), however precipitation is highly variable both spatially and temporally. The upper Assessment Unit (AU) lies within Ecoregion 21d, Southern Rockies Foothill Woodlands and Shrublands. Typical vegetation for Ecoregion 21d is pinyon-juniper woodlands and shrublands dominated by sagebrush, mountain mahogany or Gambel oak, interspersed with varied grasslands. The lower AU lies within Ecoregion 22h, Arizona/New Mexico Plateau North Central New Mexico Valleys and Mesas (Griffith, 2006). Typical vegetation for Ecoregion 22h is pinyon-juniper woodland and juniper savanna with diverse grasses. Land surfaces in the watershed, and stream geomorphology, have been impacted by historic and current

grazing, mining, road and railroad building activities. Land on the south side of the basin has been less impacted by excessive or improper livestock use than that on the north (Jan-Willem Jansens, Ecotone, pers. comm.).



**Figure 1.2. Land Use in the Galisteo Creek watershed.**

Land management in the watershed is 77% private, 9% Forest Service, 7% tribal, 6% State, and 2% Bureau of Land Management. Much of the area is encompassed by several large ranches. There is one National Pollutant Discharge Elimination System (NPDES) permitted facility in the watershed: LAC Minerals is permitted to discharge into Cunningham Creek, an ephemeral tributary in the lower watershed. Water supply for residents in the watershed is currently provided by numerous wells. Overall, groundwater recharge in the watershed is less than withdrawals and thus the water table is lowering (Stephens, 2003). In an interagency report on the watershed, the Office of the State Engineer (OSE) reported no current irrigation diversions (NM EMNRD, 2008).



**Figure 1.3. Land Ownership in the Galisteo Creek watershed.**

The Galisteo Watershed is situated within the Galisteo Basin, part of a series of basins along the Rio Grande Rift which is divided into basins by faults. The main geologic groups are volcanic and sandstone-shale- mudstone in the upper watershed and alluvium (sediment) in the middle and lower watershed.

Advancing and retreating seas during the early Mesozoic era, and again during the late Cretaceous period, deposited sands, muds, coal, gypsum and limestone in the Cerrillos area. The Laramide Orogeny uplift of the Sangre de Cristo mountain range led to erosion of the existing surface. During Cenozoic times, a series of igneous intrusions and extrusions resulted in “emplacement of a series of monzonitic stocks, plugs, laccoliths, sills, and dikes” (Disbrow and Stoll, 1957; Maynard, 2016). A system of fractures developed subsequently in the basin (Disbrow and Stoll, 1957). Veins containing economically recoverable gold, copper, lead, zinc and silver have formed in more recent

ages. As the Rio Grande Rift has deepened (subsided) over the past 1.5 million years, Galisteo Creek has cut more deeply into the geologic strata (Maynard, 2016).

Geologic strata surface and cross or confine Galisteo Creek at many locations and influence whether and how alluvial groundwater can come to the surface. It is believed that the volcanic ridge that runs from the northeast to southwest north of the village of Galisteo plays an important role in the permanent flow of water in Galisteo Creek through the village of Galisteo. There are also some springs in the Arroyo Salado on the flanks of Rowe Mesa, which are most likely fed by water stored in the forest soils on the mesa. Likewise, sandstone and volcanic rock dykes that run across Galisteo Creek at several locations between Galisteo and Cerrillos may be the cause of small springs and seeps, patches of quicksand, and additional reaches with a nearly permanent flow (Earth Works Institute, 2005).



## 1.2 Water Quality Standards

Water quality standards (WQS) for all assessment units in this document are set forth in the following sections of *New Mexico Standards for Interstate and Intrastate Surface Waters* (20.6.4 New Mexico Administrative Code [NMAC]) (NMAC, 2017):

**20.6.4.121 RIO GRANDE BASIN - Perennial tributaries to the Rio Grande in Bandelier national monument and their headwaters in Sandoval county and all perennial reaches of tributaries to the Rio Grande in Santa Fe county unless included in other segments and excluding waters on tribal lands.**

**A. Designated uses:** domestic water supply, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and primary contact; and public water supply on Little Tesuque creek, the Rio en Medio, and the Santa Fe river.

**B. Criteria:** the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: specific conductance 300  $\mu\text{S}/\text{cm}$  or less; the monthly geometric mean of *E. coli* bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less.

**20.6.4.139 RIO GRANDE BASIN - Perennial reaches of Galisteo creek and perennial reaches of its tributaries from Kewa pueblo upstream to 2.2 miles upstream of Lamy.**

**A. Designated uses:** coolwater aquatic life, primary contact, irrigation, livestock watering, domestic water supply and wildlife habitat; and public water supply on Cerrillos reservoir.

**B. Criteria:** the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: the monthly geometric mean of *E. coli* bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less.

20.6.4.900 NMAC provides criteria applicable to existing, attainable or designated uses unless otherwise specified in an AU's specific section. 20.6.4.13 NMAC lists general criteria that apply to all surface waters of the state at all times, unless a specified standard is provided elsewhere in the NMAC.

A Use Attainability Analysis (NMED/SWQB, 2013) completed in 2013 resulted in the division of Galisteo Creek into two AUs. The downstream AU was removed from Segment 121 and included in the newly created Segment 139, with a change of designated ALU from HQCW to CoolW. The upstream AU was retained in Segment 121.

### 1.3 Antidegradation and TMDLs

New Mexico's antidegradation policy, which is based on the requirements of 40 CFR Part 131.12, describes how waters are to be protected from degradation (20.6.4.8(A) NMAC). At a minimum, the policy mandates that "the level of water quality necessary to protect the existing uses shall be maintained and protected in all surface waters of the state." Furthermore, the policy's requirements must be met whether or not a segment is impaired. TMDLs are consistent with this policy because implementation of a TMDL restores water quality so that existing uses are protected and water quality criteria are achieved.

The *Antidegradation Policy Implementation Procedure* establishes the process for implementing the antidegradation policy (Appendix A of NMED/SWQB, 2011). However, specific requirements in the *Antidegradation Policy Implementation Procedure* do not apply to the Water Quality Control Commission's (WQCC) establishment of TMDLs because these types of water quality-related actions already are subject to extensive requirements for review and public participation, as well as various limitations on degradation imposed by state and federal law (NMED/SWQB, 2011).

### 1.4 Field Survey

Galisteo Creek has been divided by the SWQB into two AUs, with the dividing point located 2.2 miles above Lamy. Temperature data were collected at the SWQB Canoncito monitoring station, representing the upper AU, and at the Galisteo monitoring station, representing the lower AU. The Canoncito location is in a perennial stretch that starts at the confluence with Deer Creek and is near the bottom of the upper AU, while the Galisteo station is about midway down the lower AU. Data from these stations were assessed against WQS using established assessment protocols (NMED/SWQB, 2013) to determine whether or not designated uses were being met (Table 1.1).

**Table 1.1 Thermograph Records Used to Assess Galisteo Creek Aquatic Life Use Attainment**

| Station ID    | ALU   | Location  | Deployment Dates | TMAX (°C) | 4T3 (°C) |
|---------------|-------|-----------|------------------|-----------|----------|
| 30Galist071.2 | HQCW  | Canoncito | 5/30-8/21/2014   | 31.8      | 30.1     |
| 30Galist050.4 | CoolW | Galisteo  | 7/9/-9/1/2010    | 29.7      | NA       |

The Middle Rio Grande and its tributaries were intensively sampled by the SWQB in 2012-2014. A brief summary of the survey and the hydrologic conditions during the intensive sample period is provided in the following subsections. The full 2014 Middle Rio Grande Water Quality Survey Report can be found online at <https://www.env.nm.gov/swqb/MAS/#Streams>.

Surface water quality samples were collected monthly between March and November for the 2014 intensive SWQB study. Surface water quality monitoring stations were selected to characterize water quality of stream reaches throughout the basin (see Figure 1.5 and Table 1.2 for stations relevant to this TMDL document). Stations were located to evaluate the impact of tributary streams and to determine ambient water quality

conditions. Surface water grab sample from these stations were analyzed for a variety of chemical and physical parameters. Data results from grab sampling are housed in the SWQB provisional water quality database and uploaded to USEPA's Water Quality Exchange (WQX) database. Additional physical habitat data were obtained on Galisteo Creek in 2016, in order to provide input variables for the SSTEMP computer model.

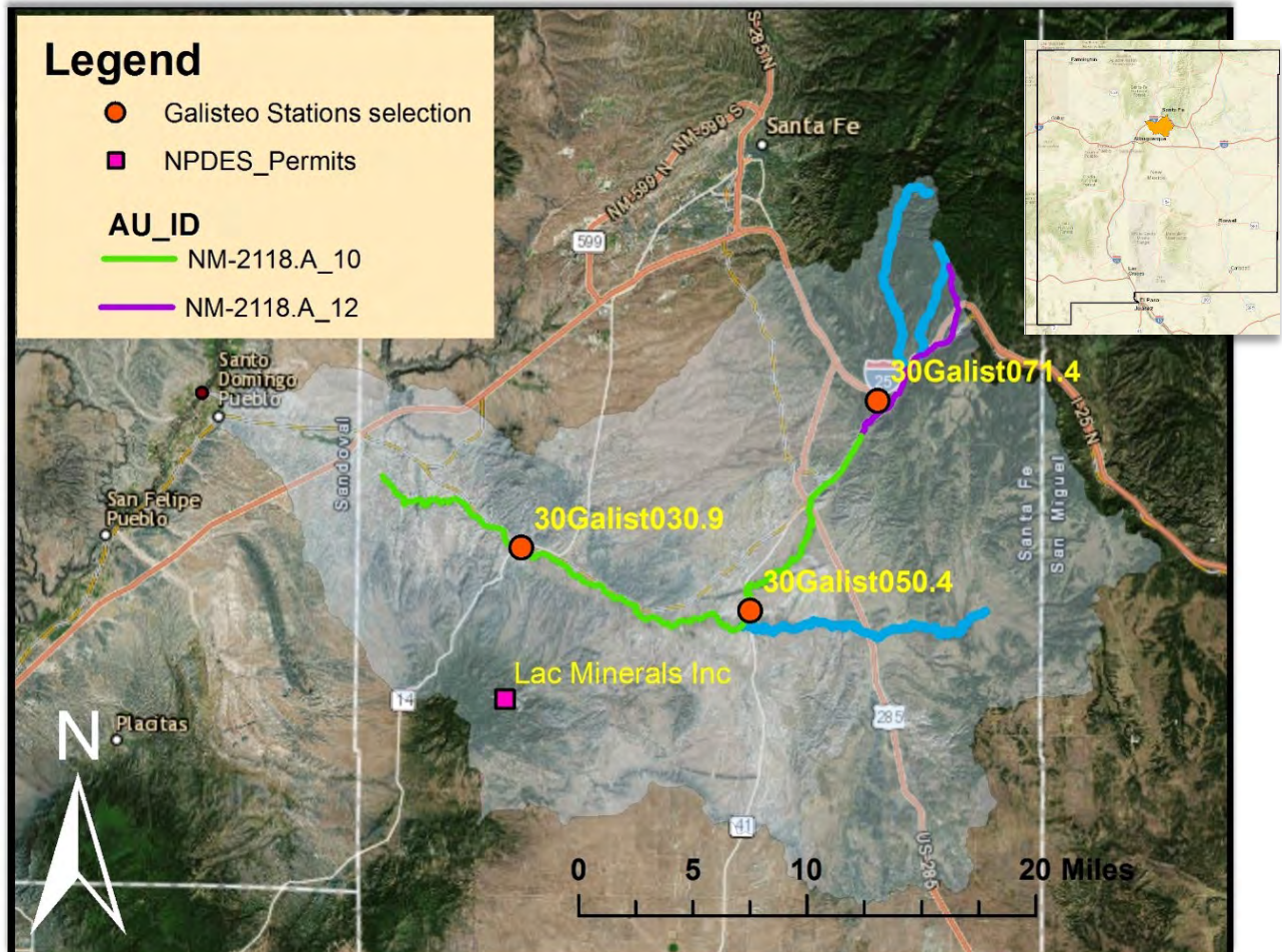


Figure 1.5 Galisteo Creek Assessment Units and Monitoring Stations.

Table 1.2 SWQB Galisteo Creek Watershed Assessment Units and Sampling Stations used in TMDL Development

| AU ID         | Assessment Unit  |
|---------------|--|
| NM-2118.A_10  | Galisteo creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) |
| NM-2118.A_12  | Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    |
| Station ID    | Station Name   |
| 30Galist030.9 | Galisteo Creek at Hwy 14 near Cerrillos                    |
| 30Galist050.4 | Galisteo Creek in Galisteo                                 |
| 30Galist071.4 | Galisteo Creek at Spirit Valley Rd in Canoncito            |

## 1.5 Hydrologic Conditions

The headwaters of the 670 square mile (mi<sup>2</sup>) watershed originate on the southern slopes of the Sangre de Cristo mountains. Average watershed elevation is 6550 ft. Two high-gradient perennial tributaries - Deer Creek and Apache Canyon - join the upper part of the creek near Canoncito. The Galisteo Creek main stem is non-perennial above Deer Creek. It becomes perennial below the Deer Creek juncture through the influence of a series of natural wetlands near the confluence. Apache Canyon includes several dams, a trout raising pond and some created wetlands. The loss of beaver and extensive mining in the 19<sup>th</sup> century were probably the earliest factors leading to channel incision (Jan-Willem Jansens, pers. comm.). Around the turn of the 20<sup>th</sup> century, the population in the valley peaked at about 30,000, concentrated in the Madrid and Cerrillos areas (NMED/SWQB and EWI, 2010).

Galisteo Creek was channelized in places to protect the railroad from Las Vegas to Albuquerque because the majority of the rail line was built in the floodplain (NMED/SWQB and EWI, 2010) and crosses the creek several times. The I-25 corridor divides a natural wetland, starving it of water. Above Canoncito, Galisteo Creek is shaded only on the north bank.

The middle watershed includes the areas of Lamy, the village of Galisteo and San Cristobal Arroyo. There is a dry reach from below Canoncito to just above Galisteo (Jan-Willem Jansens, pers. comm.). Many tributaries join Galisteo Creek downstream of the village of Galisteo, including San Cristobal, Los Angeles, La Jara, Cunningham, Arroyo Chorro and San Marcos Arroyos. Some of these arroyos deliver large quantities of sediment to Galisteo Creek. The San Cristobal Arroyo drainage, which includes Glorieta and Rowe Mesas and the White Bluffs, is the largest sub-watershed at more than 100,000 acres in size. Just below Galisteo is an irrigation dam on the main channel. Urban and exurban development is concentrated north of Galisteo Creek. In particular, the San Marcos and Gallinas sub-watersheds, covering an area of about 80 square miles, are largely built up in a mosaic of small subdivisions, surrounded by open grassland (NMED/SWQB and EWI, 2010).

The lower watershed includes Madrid, Cerrillos and part of the Kewa Pueblo. A small part extends into the Ortiz Mountains. Galisteo Creek enters the Rio Grande at an elevation of 5,180 feet. The total length of the Galisteo Creek mainstem is 53 miles. The 10 miles above the confluence with the Rio Grande are located within the boundaries of Kewa Pueblo and are therefore not considered waters of the State of New Mexico. Galisteo Dam, approximately 10.5 miles upstream of the confluence with the Rio Grande, was completed by the US Army Corps of Engineers in 1970. The dam has been perforated and there is no persistent pool above it.

## 2.0 TEMPERATURE TOTAL MAXIMUM DAILY LOAD

Water temperature influences the metabolism, behavior, and mortality of fish and other aquatic organisms. Natural temperatures of a waterbody fluctuate daily and seasonally. These natural fluctuations do not eliminate indigenous populations, but may affect existing community structure and geographical distribution of species. In fact, such temperature cycles are often necessary to induce reproductive cycles and may regulate other aspects of life history (Mount, 1969). Behnke and Zarn (1976), in a discussion of temperature requirements for endangered western native trout, recognized that populations cannot persist in waters where maximum temperatures consistently exceed 21-22°C, but they may survive brief daily periods of higher temperatures (25.5-26.7°C). Anthropogenic impacts can modify these natural temperature cycles, often leading to deleterious impacts on aquatic life communities. Such modifications may contribute to changes in geographical distribution of species and their ability to persist in the presence of additional challenges such as introduced species.

Monitoring of Galisteo Creek for temperature was conducted by SWQB in 2010 and 2014. Thermographs (temperature data loggers) were set to record once every hour in July and August of 2010, at the Galisteo village monitoring station, and once every 15 minutes from May through August of 2014, at the Canoncito monitoring station. Thermograph data were assessed using Appendix E of the *State of New Mexico Procedures for Assessing Standards Attainment for the Integrated CWA §303(d)/§305(b) Water Quality Monitoring and Assessment Report [Assessment Protocol]* (NMED/SWQB 2013). Physical habitat data were collected in 2016 to generate stream geometry variables for input to the Stream Segment Temperature model (SSTEMP).

All sampling and assessment techniques used during the 2014 intensive and 2016 additional data SWQB surveys are detailed in the assessment protocols (NMED/SWQB, 2013) and *Quality Assurance Project Plan* (NMED/SWQB, 2016). The temperature impairment of the lower part of Galisteo Creek was documented by thermograph deployment in 2010. Thermograph deployment during the 2014 survey at that location was unsuccessful. As a result of the 2014 monitoring efforts, temperature impairment was determined for the upper part of Galisteo Creek. Accordingly these impairments were either added to or remained on the New Mexico's 2014-2016 CWA Integrated §303 (d)/305(b) list (NMED/SWQB, 2014).

### 2.1 Target Loading Capacity

For this TMDL document, target values for temperature are based on the reduction in solar radiation necessary to achieve numeric criteria as predicted by a temperature model. Increases in solar radiation in a given AU can often be correlated to changes in shade and/or canopy cover. Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts) has a designated High Quality Cold Water (HQCW) aquatic life use. Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) has a designated Coolwater (CoolW) aquatic life use. Temperature criteria for aquatic life uses in New Mexico are shown on Table 2.1. New Mexico's aquatic life temperature criteria are expressed as 4T3, 6T3 and TMAX. TMAX is the maximum recorded temperature, 4T3 means the temperature not to be exceeded for four or more consecutive hours in a 24-hour period on more than three consecutive days, and 6T3 means the temperature not to be exceeded for six or more consecutive hours in a 24-hour period on more than three consecutive days.

**Table 2.1 Aquatic Life Use Temperature Criteria (°C)**

| <i>Criterion</i> | <i>High<br/>Quality<br/>Coldwater</i> | <i>Coldwater</i> | <i>Marginal<br/>Coldwater</i> | <i>Coolwater</i> | <i>Warmwater</i> | <i>Marginal<br/>warmwater</i> |
|------------------|---------------------------------------|------------------|-------------------------------|------------------|------------------|-------------------------------|
| 4T3              | 20                                    | -                | -                             | -                | -                | -                             |
| 6T3              | -                                     | 20               | 25                            | -                | -                | -                             |
| TMAX             | 23                                    | 24               | 29                            | 29               | 32.2             | 32.2                          |

## 2.2 Flow

40 CFR 130.7(c)(1) requires states to calculate a TMDL using critical conditions for stream flow. The highest in-stream water temperatures typically occur during the hottest times of the year when the daytime is at its longest and solar radiation is at its highest. For New Mexico, the beginning of summer (before the monsoon season) is the hottest time of the year and coincides with the dry season, and consequently the lowest stream flows. Therefore, the critical flow condition used to calculate these temperature TMDLs was obtained using a 4-day, 3-year low-flow frequency (4Q3) regression model. The 4Q3 is the minimum average four consecutive day flow that occurs with a frequency of once every three years.

When available, U.S. Geological Service (USGS) gages are used to estimate flow. There have been several USGS gaging stations in the Galisteo Creek watershed associated with the reaches presented in this document. However recent daily flow data is available only from 08317950 – Galisteo Creek below Galisteo Dam, NM. As indicated by its name, this gage is located below the dam near the bottom of the lower AU and does not reflect hydrography of the reaches above the dam. Flow at the gage is usually zero and only storm flows are reflected in the record.

Because the available gage data are not suitable to calculate the critical low flow, an analysis method developed by Waltemeyer (2002) was used to estimate the 4Q3. In Waltemeyer's analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 ft in elevation). The average elevation of the Galisteo Creek watershed above Canoncito is above 7,500 ft, so the mountainous regions regression equation was used for the upstream AU (2.2 mi above Lamy to headwaters). The following regression equation is based on data from 40 gaging stations located above 7,500 ft in elevation with non-zero discharge (Waltemeyer 2002):

$$4Q3 = 7.3287 \times 10^{-5} DA^{0.70} P_w^{3.58} S^{1.35}$$

Where:

- 4Q3 = Four-day, three-year low-flow frequency (cfs)
- DA = Drainage area (mi<sup>2</sup>)
- P<sub>w</sub> = Average basin mean winter precipitation (inches)
- S = Average basin slope (%)

The average elevation of the Galisteo watershed above the Kewa Pueblo boundary is below 7,500 ft, so the statewide regression equation was used for the downstream AU (Kewa boundary to 2.2 mi above Lamy). The

following regression equation is based on data from 50 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 = 1.2856 \times 10^{-4} DA^{0.42} P_w^{3.16}$$

Where:

- 4Q3 = Four-day, three-year low-flow frequency (cfs)
- DA = drainage area (mi<sup>2</sup>)
- P<sub>w</sub> = average basin mean winter precipitation (inches)

The 4Q3 values calculated using Waltemeyer's method are presented in Table 2.2. Parameters used in the calculation were determined using Basins, a GIS application, and the USGS Stream Stats application, Version 3 ([http://water.usgs.gov/osw/streamstats/new\\_mexico.html](http://water.usgs.gov/osw/streamstats/new_mexico.html)).

**Table 2.2 Critical Flow**

| Assessment Unit  | 4Q3 Flow (cfs) |
|--|----------------|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    | 0.1            |
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 0.35           |

It is important to remember that the TMDL is a value calculated at a defined critical condition as part of a planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality is the goal.

The specific inflow and outflow values used in the SSTEMP model are discussed in detail in Appendix B.

## 2.3 Load Calculations

The SSTEMP Model, Version 2.0.8, developed by the USGS Biological Resource Division (Bartholow 2002) was used to predict stream temperatures based on watershed geometry, hydrology, and meteorology. The model predicts mean, minimum, and maximum daily water temperatures throughout a stream reach by estimating the heat gained or lost from a parcel of water as it passes through a stream segment (Bartholow 2002). The predicted temperature values are compared to actual thermograph readings measured in the field in order to calibrate the model. The SSTEMP model identifies current stream and/or watershed characteristics that influence stream temperatures. The model also quantifies the maximum loading capacity of the stream to meet water quality criteria for temperature (Figures 2.1 and 2.2). The model is important for estimating the effects of changes to the parameters influencing stream temperature. It can also be used to identify possible implementation activities which may be of use for reducing the water temperature, by identifying which parameters are most influential to the impairment.

SSTEMP Version 2.0.8

File View Help

**Hydrology**

Segment Inflow (cfs) 0.100

Inflow Temperature (°C) 19.400

Segment Outflow (cfs) 0.350

Accretion Temp. (°C) 10.900

**Geometry**

Latitude (degrees) 35.444

Dam at Head of Segment ☐

Segment Length (mi) 33.500

Upstream Elevation (m) 2042.00

Downstream Elevation (m) 1700.00

Width's A Term (s/ft²) 3.100

B Term where  $W = A * Q^{**B}$  0.424

Manning's n 0.030

**Meteorology**

Air Temperature (°C) 28.300

☒ Maximum Air Temp (°C) 37.200

Relative Humidity (%) 37.000

Wind Speed (mph) 8.000

Ground Temperature (°C) 10.900

Thermal gradient (j/m²/s/C) 1.650

Possible Sun (%) 76.000

Dust Coefficient 5.000

Ground Reflectivity (%) 25.000

Solar Radiation (j/m²/s) 259.000

**Shade**

Total Shade (%) 2.400

**Time of Year**

Month/day (mm/dd) 07/20

**Intermediate Values**

Day Length (hrs) = 14.068

Slope (ft/100 ft) = 0.634

Width (ft) = 1.647

Depth (ft) = 0.173

**Mean Heat Fluxes at Inflow (j/m²/s)**

Convect. = +62.93    Atmos. = +364.97

Conduct. = -14.03    Friction = +0.49

Evapor. = -111.49    Solar = +252.78

Back Rad. = -395.83    Vegetat. = +10.39

Net = +170.22

**Optional Shading Variables**

Segment Azimuth (degrees) -15.000

|                                | West Side | East Side |
|--------------------------------|-----------|-----------|
| Topographic Altitude (degrees) | 25.000    | 15.000    |
| Vegetation Height (ft)         | 25.000    | 25.000    |
| Vegetation Crown (ft)          | 15.000    | 20.000    |
| Vegetation Offset (ft)         | 5.000     | 15.000    |
| Vegetation Density (%)         | 50.000    | 75.000    |

**Model Results - Outflow Temperature**

Predicted Mean (°C) = 23.69

Estimated Maximum (°C) = 30.33

Approximate Minimum (°C) = 17.04

Mean Equilibrium (°F) = 75.29

Maximum Equilibrium (°F) = 86.77

Minimum Equilibrium (°F) = 63.80

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Figure 2.1. Example of SSTEMP output for Galisteo Creek (Kewa boundary to 2.2 mi above Lamy).

SSTEMP Version 2.0.8

File View Help

**Hydrology**

Segment Inflow (cfs) 0.100

Inflow Temperature (°C) 9.400

Segment Outflow (cfs) 0.100

Accretion Temp. (°C) 9.400

**Geometry**

Latitude (degrees) 35.538

Dam at Head of Segment ☐

Segment Length (mi) 3.600

Upstream Elevation (m) 2175.00

Downstream Elevation (m) 2042.00

Width's A Term (s/ft²) 6.460

B Term where  $W = A * Q^{**B}$  0.119

Manning's n 0.860

**Meteorology**

Air Temperature (°C) 26.700

☒ Maximum Air Temp (°C) 36.700

Relative Humidity (%) 15.000

Wind Speed (mph) 9.000

Ground Temperature (°C) 9.400

Thermal gradient (j/m²/s/C) 1.650

Possible Sun (%) 83.000

Dust Coefficient 5.000

Ground Reflectivity (%) 15.000

Solar Radiation (j/m²/s) 313.000

**Shade**

Total Shade (%) 8.000

**Time of Year**

Month/day (mm/dd) 06/30

**Intermediate Values**

Day Length (hrs) = 14.373

Slope (ft/100 ft) = 2.296

Width (ft) = 4.912

Depth (ft) = 0.216

**Mean Heat Fluxes at Inflow (j/m²/s)**

Convect. = +127.26 Atmos. = +302.49

Conduct. = +0.00 Friction = +0.43

Evapor. = -100.91 Solar = +287.96

Back Rad. = -344.42 Vegetat. = +33.89

Net = +306.69

**Optional Shading Variables**

Segment Azimuth (degrees) 45.000

|                                | West Side | East Side |
|--------------------------------|-----------|-----------|
| Topographic Altitude (degrees) | 25.000    | 15.000    |
| Vegetation Height (ft)         | 3.000     | 3.000     |
| Vegetation Crown (ft)          | 3.000     | 3.000     |
| Vegetation Offset (ft)         | 15.000    | 15.000    |
| Vegetation Density (%)         | 8.000     | 8.000     |

**Model Results - Outflow Temperature**

Predicted Mean (°C) = 19.71

Estimated Maximum (°C) = 27.25

Approximate Minimum (°C) = 12.18

Mean Equilibrium (°F) = 67.48

Maximum Equilibrium (°F) = 81.18

Minimum Equilibrium (°F) = 53.78

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**Figure 2.2 Example of SSTEMP output for Galisteo Creek (2.2 mi above Lamy to headwaters).**

A series of assumptions are associated with the SSTEMP run conditions. Running the model outside of these assumptions will often result in inaccuracies or model instability. The assumptions used in the development of SSTEMP that are most relevant to the development of the present TMDLs are listed below. For a complete list of assumptions and model deficiencies, please see the SSTEMP user manual (Bartholow 2002).

- Water in the system is instantaneously and thoroughly mixed at all times; there is no lateral temperature distribution across channel OR vertical gradients in pools
- Stream geometry is characterized by mean conditions
- Solar radiation and other meteorological and hydrological variables are 24-hour means
- Distribution of lateral inflow is uniformly apportioned throughout the segment length
- Manning's n and travel time do not vary as functions of flow
- Modeled/representative time periods must be long enough for water to flow the full length of the segment

- SSTEMP is not able to model cumulative effects; for example, adding or deleting vegetation mathematically is not the same as in real life

## **2.4 Margin of Safety (MOS)**

The CWA requires that each TMDL be calculated with a MOS. This statutory requirement that TMDLs incorporate a MOS is intended to account for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality. A MOS may be expressed as unallocated assimilative capacity or conservative analytical assumptions used in establishing the TMDL (e.g., derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions). The MOS may be implicit, utilizing conservative assumptions for calculation of the loading capacity, WLAs, and LAs. The MOS may also be explicitly stated as an added separate quantity in the TMDL calculation.

In order to develop this temperature TMDL, the following conservative assumptions were used to parameterize the model:

- Data from the warmest time of the year were used in order to capture the seasonality of temperature exceedences.
- Critical upstream and downstream low flows were used because assimilative capacity of the stream to absorb and disperse solar heat is decreased during these flow conditions.

As detailed in Appendix D, a variety of hydrologic, geomorphologic, and meteorological data were used to parameterize the SSTEMP model. Because of the quality of data and information that was put into this model and the continuous field monitoring data used to verify these model outputs, an explicit MOS of 10% is assigned to this TMDL. The actual calculated MOS varies slightly from exactly 10%, due to rounding of shade percent values to the nearest 1%.

## **2.5 Waste Load Allocation**

There is one active NPDES permitted point source in the watershed but it does not discharge directly to Galisteo Creek. Permit NM0028711, issued to LAC Minerals (USA), Inc., is located on Cunningham Gulch approximately 6 miles from the nearest point on the Galisteo Creek channel (Figure 1.5). The permit authorizes discharge from the mine's open pit pool. SWQB does not believe that this facility needs a WLA for the following reasons:

1. The level of mine pit water is currently about 300 feet below the surrounding ground surface and it has never discharged to Cunningham Gulch (David Wykoff, LAC Minerals, pers. comm.).
2. Per the 18 Unclassified Non-Perennial Stream Segment Use Attainability Analysis (technically approved by EPA on January 30, 2013), Cunningham Gulch is listed as an ephemeral stream in 20.6.4.97 NMAC.
3. Even if the facility were to discharge, and the discharge entered Galisteo Creek, the flow would not constitute a substantial contribution affecting water temperature, because the volume reaching the confluence would likely be very small, and because the water temperature would likely be similar to that of Galisteo Creek.

Sediment and associated contaminants are considered components of industrial storm water discharges covered under National Pollutant Discharge Elimination System (NPDES) General Permits. Stormwater discharges from construction activities are transient, occurring mainly during the construction itself, and then only during

storm events. Coverage under the NPDES Construction General Permit (CGP) for construction sites greater than one acre, or less than one acre if they are part of a common plan of development, requires preparation of a Storm Water Pollution Prevention Plan (SWPPP) that includes identification and control of all pollutants associated with the construction activities to minimize impacts to water quality. The current CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, and managerial and structural solids, erosion, and sediment control Best Management Practices (BMPs), and/or other controls. BMPs and other controls are designed to prevent to the maximum extent practicable an increase in sediment load and flow velocity during and after construction compared to pre-construction conditions to the water body, or an increase in a sediment-related parameter, such as total suspended solids, turbidity, siltation, stream bottom deposits, etc., in order to assure that waste load allocations and/or applicable water quality standards, including the antidegradation policy, are met. This requirement applies both during and after construction operations.

Stormwater discharges from industrial activities and facilities, based on industrial classification codes, may be eligible for coverage under the current NPDES Multi-Sector General Permit (MSGP). The MSGP also requires preparation of a SWPPP. Some of the industrial facilities and activities covered under the MSGP have technology based effluent limitation and/or benchmark monitoring for pollutants. The current MSGP includes state-specific requirements that the benchmark values reflect State of New Mexico WQS.

It is not possible to calculate individual WLAs for facilities covered by the General Permits at this time using the available tools. While these sources are not given individual allocations, they are addressed through other means, including BMPs, and other stormwater pollution prevention conditions. Implementation of a SWPPP that meets the requirements of a General Permit is generally assumed to be consistent with this TMDL. Loads that are in compliance with the General Permits are therefore currently included as part of the LA. Therefore the WLA for this TMDL is zero.

## **2.6 Load Allocation**

Water temperature can be expressed as heat energy per unit volume. SSTEMP provides an estimate of heat energy expressed in joules per square meter per second ( $\text{J/m}^2/\text{s}$ ). The following information relevant to the model runs used to determine temperature TMDLs is taken from the SSTEMP documentation (Bartholow 2002). The specific flow, stream geometry, and meteorological values used in the SSTEMP model are discussed in detail in Appendix B.

The program will predict the minimum, mean, and maximum daily water temperature for the set of variables input into the model. The theoretical basis for the model is strongest for the mean daily temperature. The predicted maximum is largely an estimate and likely to vary widely with the maximum daily air temperature. The predicted minimum is computed by subtracting the difference between maximum and mean, from the mean; but the predicted minimum is always positive (Bartholow 2002).

Tables 3.4 and 3.5 detail model outputs for AUs on Galisteo Creek. SSTEMP was first calibrated against thermograph data. Initial conditions were determined. As the percent total shade was increased, the maximum 24-hour temperature decreased until the appropriate temperature criterion was achieved. The calculated 24-hour solar radiation component is the maximum solar load that can occur in order to meet the WQS (i.e., the target capacity). In order to calculate the actual LA, the WLA and MOS were subtracted from the target capacity (TMDL):

$$WLA + LA + MOS = TMDL$$

For Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts), the HQCW WQS for 4T3 water temperature of 20°C is achieved when the percent total shade is increased from 8% to 81%. According to the SSTEMP model, the actual LA of 53.21 j/m<sup>2</sup>/s, which includes an MOS of 10%, is achieved when the shade is further increased to 83% (Table 2.3).

For Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy), the CoolW WQS for maximum water temperature of 29°C is achieved when the percent total shade is increased from 2.4 to 21%. According to the SSTEMP model, the actual LA of 183.89 j/m<sup>2</sup>/s, which includes an MOS of 10%, is achieved when the shade is further increased to 29% (Table 2.4).

The MOS is estimated to be 10% of the target load calculated by the modeling runs. The load reductions that would be necessary to meet the target load were calculated to be the difference between the calculated target load and the measured load (i.e., current field condition), and are shown in Tables 2.4 and 2.5.

**Table 2.3 Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts) - HQCW**

| WQS 4T3 (HQCW)  | Model Run Date | Segment Length (miles)  | Solar Radiation Component per 24-Hours (j/m <sup>2</sup> /s) | % Total Shade | Modeled Temperature (°C)                        |
|---|----------------|-------------------------|--|---------------|---|
| 20°C  | 6/30/2014      | 3.6 (perennial portion) | <b>Current Field Condition:</b><br>287.96                    | 8             | Minimum: 12.18<br>Mean: 19.71<br>Maximum: 27.25 |
| TEMPERATURE ALLOCATIONS   |                |                         |  |               |   |
| <sup>(a)</sup> 24-HOUR ACHIEVEMENT OF CRITERION FOR TEMPERATURE   |                |                         | 59.47 <sup>(a)</sup>   | 81            | Minimum: 9.72<br>Mean: 14.82<br>Maximum: 19.93  |
| <sup>(b)</sup> 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE CRITERION WITH A 10% MARGIN OF SAFETY   |                |                         | 53.21 <sup>(b)</sup>   | 83            | Minimum: 9.66<br>Mean: 14.68<br>Maximum: 19.69  |
| <div>Actual reduction in solar radiation necessary to meet surface WQS for temperature:</div> <div>Current Condition –Load Allocation =<br/>287.96 – 53.21 = 234.75 j/m<sup>2</sup>/s</div> |                |                         |  |               |   |

**Table 2.4 Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) - CoolW**

| WQS T <sub>MAX</sub><br>(CoolW)   | Model Run<br>Date | Segment<br>Length (miles) | Solar Radiation<br>Component per<br>24-Hours (j/m <sup>2</sup> /s) | %<br>Total<br>Shade | Modeled<br>Temperature (°C)                     |
|---|-------------------|---------------------------|--|---------------------|---|
| 29°C  | 7/20/2010         | 33.5                      | <b>Current Field<br/>Condition:</b><br>252.78                      | 2.4                 | Minimum: 17.04<br>Mean: 23.69<br>Maximum: 30.33 |
| TEMPERATURE ALLOCATIONS<br><br><sup>(a)</sup> 24-HOUR ACHIEVEMENT OF<br>CRITERION FOR TEMPERATURE<br><br><sup>(b)</sup> 24-HOUR LOAD ALLOCATION (LA)<br>NEEDED TO ACHIEVE CRITERION WITH<br>A 10% MARGIN OF SAFETY<br><br><div style="border: 1px solid black; padding: 10px; background-color: #e6f2ff;">             Actual reduction in solar radiation<br/>necessary to meet surface WQS for<br/>temperature:<br/><br/>             Current Condition –Load Allocation =<br/><br/> <math>252.78 - 183.89 = 68.89 \text{ j/m}^2/\text{s}</math> </div> |                   |                           | 204.61 <sup>(a)</sup>  | 21                  | Minimum: 16.57<br>Mean: 22.76<br>Maximum: 28.95 |
|   |                   |                           | 183.89 <sup>(b)</sup>  | 29                  | Minimum: 16.37<br>Mean: 22.35<br>Maximum: 28.33 |

SSTEMP may be used to compute, one at a time, the sensitivity to input values. This increases and decreases most active input by 10% and displays a screen for changes to mean and maximum temperatures. The “Relative Sensitivity” schematic graph that accompanies the display gives an indication of which variables most strongly influence the results (Bartholow 2002). Sensitivity analysis outputs for both AUs are shown in Appendix B.

The sensitivity analysis indicates that maximum air temperature and solar radiation have the most influence on the estimated maximum stream temperatures in Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts), with mean air temperature, relative humidity and wind speed having a secondary level of influence. Maximum air temperature, solar radiation and mean air temperature have the most influence on the estimated maximum stream temperatures in Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy), with relative humidity and wind speed having a secondary level of influence.

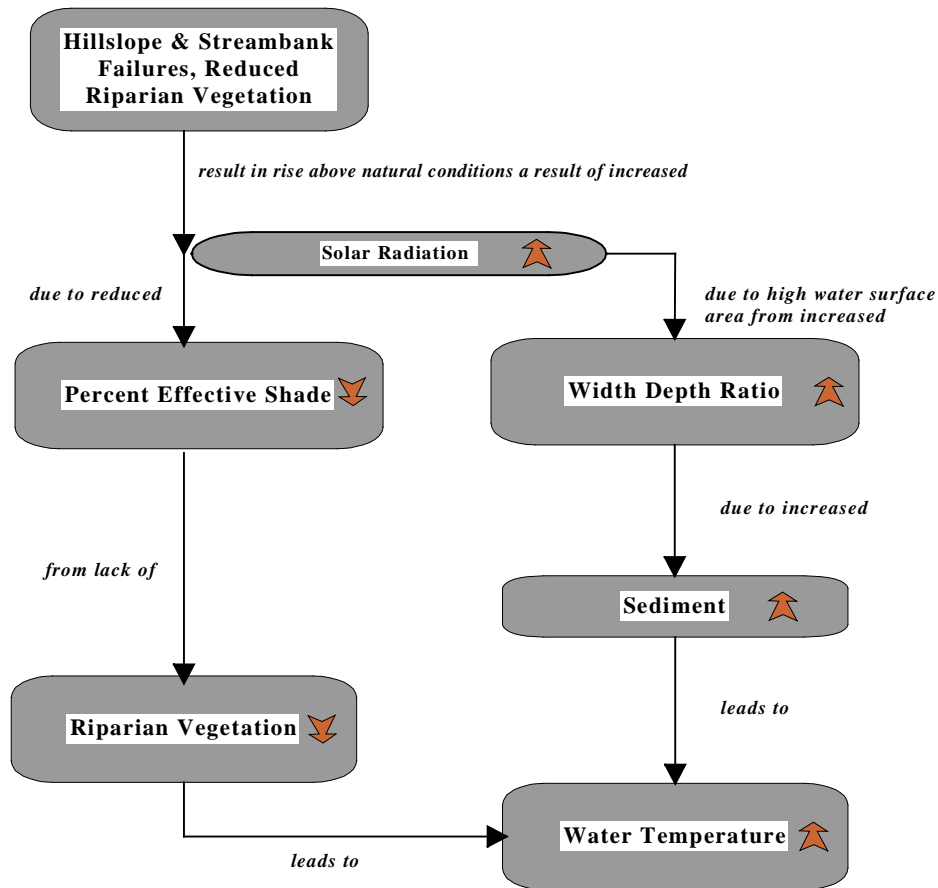
## 2.7 Identification and Description of Pollutant Source(s)

SWQB fieldwork includes an assessment of the probable sources of impairment (Appendix A). Probable Source Sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The list of “Probable Sources” is not intended to single out any single land owner or particular land management activity and generally includes several sources per pollutant. Table 2.5 displays probable pollutant sources that have the possibility to contribute to increased temperature in each Galisteo Creek AU as determined by field reconnaissance and knowledge of watershed activities. The draft probable source list will be reviewed and modified, as necessary, with watershed group/stakeholder input during the TMDL public meeting and comment period. Probable sources of temperature impairments will be further evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

**Table 2.5 Probable Source Summary for Temperature**

| NM-2118.A_12 (Perennial prt 2.2 mi abv Lamy to hdwts)    |                              |
|--|------------------------------|
| Highway/road/bridge runoff                               | Rangeland grazing            |
| Stream channel incision                                  | Bridges/culverts/RR crossing |
| Logging - legacy   | Gravel or dirt roads         |
| Abandoned mines/tailings                                 | Low water crossing           |
| NM-2118.A_10 (Perennial prt Kewa bnd to 2.2 mi abv Lamy) |                              |
| Highway/road/bridge runoff                               | Stream channel incision      |
| Residences/buildings                                     | Abandoned mines/tailings     |
| Channelization   | Bridges/culverts/RR crossing |
| Gravel or dirt roads                                     | Paved roads                  |
| Dams/diversions  | Rangeland grazing            |

A variety of factors impact stream temperature (Figure 2.3). Decreased effective shade levels may result from reduction of riparian vegetation. When canopy densities are reduced, thermal loading increases in response to the increase in incident solar radiation. Likewise, it is well documented that past hydromodification activities have led to channel incision and widening. Wider stream channels also increase the stream surface area exposed to sunlight, thereby increasing heat transfer. Riparian area and channel morphology disturbances may also be attributed to past, and to some extent current, rangeland grazing practices that have resulted in reduction of riparian vegetation and streambank destabilization. These nonpoint sources of pollution primarily affect the water temperature through increased solar loading by: (1) increasing stream surface solar radiation and (2) increasing stream surface area exposed to solar radiation.



**Figure 2.3 Factors Impacting Stream Temperature**

Riparian vegetation, stream morphology, hydrology, climate, geographic location, and aspect all influence stream temperature. Although climate, geographic location, and aspect are outside of human control, the condition of the riparian area, channel morphology, and hydrology can be affected by land use activities. Specifically, the elevated summertime stream temperatures attributable to anthropogenic causes in the Galisteo watershed result from the following conditions:

1. Channel widening (i.e., increased width to depth ratios) that has increased the stream surface area exposed to incident solar radiation;
2. Riparian vegetation disturbance that has reduced stream surface shading, riparian vegetation height and density
3. Reduced summertime base flows that result from instream impoundments and withdrawals and/or inadequate riparian vegetation; and,
4. Inflow from heated surfaces, such as road pavement, buildings, bare land, etc. and the flow of water over hardened channel bottoms and walls.

Base flows are maintained with a functioning riparian system so that loss of a functioning riparian system may lower and sometimes eliminate baseflows. Although removal of upland vegetation has been shown, in some cases, to increase water yield, studies show that removal of riparian vegetation along the stream channel subjects

the water surface and adjacent soil surfaces to wind and solar radiation, partially offsetting the reduction in transpiration with evaporation. In losing stream reaches, increased temperatures can result in increased streambed infiltration, which can result in lower base flow (Constrantz et al. 1994).

Vegetation density increases will provide necessary shading, as well as encourage bank-building processes in severe hydrologic events. The 83% canopy cover at which the TMDL is achieved at Galisteo Creek (2.2 mi above Lamy to headwaters in SSTEMP, may not be practically achievable in this setting. However shade is only one avenue which may be pursued to decrease water temperature and ultimately meet WQS. Changes in geomorphological parameters might also prove useful. For example, unstable channels may be characterized by excess sedimentation. SWQB encourages stakeholders to pursue whatever options seem to be the best fit for each particular watershed or project with the ultimate goal being that the stream meets the WQS.

Channel morphology improvements to the Apache Canyon tributary, and to the Galisteo Creek mainstem channel above the perennial portion, have potential to improve stability of both temperature impaired AUs. Upland watershed improvements on the north side of the watershed, and increasing the area of riparian buffer zones, also hold potential to improve temperature and stability conditions in the lower AU (NMED/SWQB and EWI, 2010, and J.W. Jansens, pers. comm.).

## **2.8 Consideration of Seasonal Variation**

Section 303(d)(1) of the CWA requires TMDLs to be “established at a level necessary to implement the applicable WQS with seasonal variations.” Both stream temperature and flow vary seasonally and from year to year. Water temperatures are coolest in the winter and early spring months.

The warmest stream temperatures correspond to prolonged solar radiation exposure, warmer air temperature, and low flow conditions. These conditions occur during late summer and early fall and promote the warmest seasonal instream temperatures. It is assumed that if critical conditions are met, coverage of any potential seasonal variation will also be met.

## **2.9 Future Growth**

Galisteo Basin is part of the Jemez y Sangre water planning region, which includes all of Los Alamos County, most of Santa Fe County and small parts of Sandoval and Rio Arriba Counties. The University of New Mexico Bureau of Business and Economic Research projects that the population of the Jemez y Sangre water planning region will grow from 178,665 people in 2005 to 216,756 in 2060, with most of that growth taking place in Santa Fe County. Projected aging of the population is likely to result in a decrease of average household size (more housing units per individual) (BBER, 2008). Future growth in the Jemez y Sangre water planning region may lead to increased water temperatures in the Galisteo watershed that could be controlled with best management practices (BMPs). BMPs should continue to be utilized in this watershed to improve road conditions and grazing allotments and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit.

Any future growth would be considered part of the existing load allocation, assuming persistence of the present hydrologic conditions.

### 3.0 Applicable Regulations

New Mexico's Water Quality Act, NMSA 1978 §§ 74-6-1 to -17 (Act), authorizes the WQCC to "promulgate and publish regulation to prevent or abate water pollution in the state" and to require permits. The Act authorizes a constituent agency to take enforcement action against any person who violates a water quality standard. Several statutory provisions on nuisance law could also be applied to NPS water pollution. The Act also states in §74-6-12(a):

*The Water Quality Act (this article) does not grant to the commission or to any other entity the power to take away or modify the property rights in water, nor is it the intention of the Water Quality Act to take away or modify such rights.*

In addition, the State of New Mexico Surface Water Quality Standards (see 20.6.4.6.C NMAC) (NMAC, 2012) states:

*Pursuant to Subsection A of Section 74-6-12 NMSA 1978, this part does not grant to the water quality control commission or to any other entity the power to take away or modify property rights in water.*

New Mexico policies are in accordance with the federal Clean Water Act §101(g):

*It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this Act. It is the further policy of Congress that nothing in this Act shall be construed to supersede or abrogate rights to quantities of water which have been established by any State. Federal agencies shall co-operate with State and local agencies to develop comprehensive solutions to prevent, reduce and eliminate pollution in concert with programs for managing water resources.*

New Mexico's CWA §319 Program has been developed in a coordinated manner with the State's 303(d) process. All watersheds that are targeted in the annual §319 request for proposal process coincide with the State's biennial impaired waters list as approved by USEPA. The State has given a high priority for funding, assessment, and restoration activities to these watersheds.

As a constituent agency, NMED has the authority under NMSA 1978 Section 74- 6-10 to issue a compliance order or commence civil action in district court for appropriate relief if NMED determines that actions of a "person" (as defined in the Act) have resulted in a violation of a water quality standard including a violation caused by a NPS. The NMED NPS water quality management program has historically strived for and will continue to promote voluntary compliance to NPS water pollution concerns by utilizing a voluntary, cooperative approach. The State provides technical support and grant monies for implementation of BMPs and other NPS prevention mechanisms through §319 of the CWA. Since portions of this TMDL will be implemented through NPS control mechanisms, the New Mexico Watershed Protection Program will target efforts to this and other watersheds with TMDLs.

In order to obtain reasonable assurances for implementation in watersheds with multiple landowners, including federal, state, and private land, NMED has established Memoranda of Understanding (MOUs) with various federal agencies, in particular the U.S. Forest Service and the Bureau of Land Management. MOUs have also

been developed with other state agencies, such as the New Mexico Department of Transportation. These MOUs provide for coordination and consistency in dealing with NPS issues.

The time required to attain standards for all reaches is estimated to be approximately 10-20 years. This estimate is based on a five-year time frame implementing several watershed projects that may not be starting immediately or may be in response to earlier projects. Stakeholders in this process will include SWQB, and other parties identified in the WBP. The cooperation of watershed stakeholders will be pivotal in the implementation of these TMDLs as well.

## **4.0 Public Participation**

Public participation was solicited in development of this TMDL. A Public Comment Draft Galisteo Creek TMDL report was made available for a 30-day comment period beginning on April 3, 2017, and a public meeting was held on April 11 at the Oliver La Farge Library in Santa Fe from 5:30 to 7:30. Three comments were received during the public comment period. Response to public comments is included as Appendix C of the final TMDL report. Executive Summary Tables ES-1 and ES-2 were revised in response to public comment. No other substantial changes were made to the Public Comment Draft.

Once the TMDL is approved by the WQCC and USEPA Region 6, the next step for public participation is development or revision of the WBP and implementation of watershed improvement projects including those that may be funded by CWA §319(h) grants. The WBP development and revision process is open to any member of the public who wants to participate.

## 5.0 References

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**APPENDIX A**  
SOURCE DOCUMENTATION

“Sources” are defined as activities that may contribute pollutants or stressors to a water body (USEPA 1997). The list of “Probable Sources of Impairment” in the [Integrated 303\(d\)/305\(b\) List, Total Maximum Daily Load](#) documents (TMDL’s), and Watershed-Based Plans (WBP’s) is intended to include any and all activities that could be contributing to the identified cause of impairment. Data on Probable Sources is routinely gathered by Monitoring and Assessment Section staff and Watershed Protection Section staff during water quality surveys and watershed restoration projects and is housed in the Assessment Database (ADB version 2). ADB was developed by USEPA to help states manage information on surface water impairment and to generate §303(d)/ §305(b) reports and statistics. More specific information on Probable Sources of Impairment is provided in individual watershed planning documents (e.g., TMDL’s, WBP’s, etc) as they are prepared to address individual impairments by assessment unit.

USEPA through guidance documents strongly encourages states to include a list of Probable Sources for each listed impairment. According to the 1998 305(b) report guidance, “..., *states must always provide aggregate source category totals...*” in the biennial submittal that fulfills CWA section 305(b)(1)(C) through (E) (USEPA 1997). The list of “Probable Sources” is not intended to single out any particular land owner or single land management activity and has therefore been labeled “Probable” and generally includes several sources for each known impairment.

The approach for identifying “Probable Sources of Impairment” was recently modified by SWQB. Any new impairment listing will be assigned a Probable Source of “Source Unknown.” Probable Source Sheets will continue to be filled out during watershed surveys and watershed restoration activities by SWQB staff. Information gathered from the Probable Source Sheets will be used to generate a draft Probable Source list in consequent TMDL planning documents. These draft Probable Source lists will be finalized with watershed group/stakeholder input during the pre-survey public meeting, TMDL public meeting, WBP development, and various public comment periods. The final Probable Source list in the approved TMDL will be used to update the subsequent Integrated List.

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## Probable Source Development Process

### **303(d)/305(b) Integrated List**

New impaired waters list "unknown" as the default Probable Source. Existing listings retain historic Probable Sources. *Public comment on Probable Sources list sought during the public comment period every two years for the new Integrated List.*

### **Water Quality Surveys**

*Public comment solicited by SWQB staff during the pre-survey public meeting(s) held in the watershed.*

SWQB staff complete Probable Source Identification form throughout the course of the water quality survey.

### **TMDL Development**

*TMDL staff work with Watershed Protection staff in order to solicit input from stakeholders in the watershed during TMDL development.*

*TMDL staff solicit input from stakeholders during the TMDL public meetings held during the TMDL public comment period.*

### **Watershed Groups & WBP Development**

*SWQB staff continue to refine the Probable Source List through the development of watershed groups and/or WBP documents in the watershed with continued input by the public.*

All input received will be included on the next 303(d)/305(b) Integrated Report and subsequent TMDLs.



New Mexico Environment Department  
**Surface Water Quality Bureau**

**Figure A1. Probable Source Development Process and Public Participation Flowchart**

### Help Us Identify Probable Sources of Impairment

|   |
|---|
| <b>Name:</b>  |
| Phone Number (optional):  |
| Email or Mailing Address (optional):  |
|   |
| <b>Date:</b>  |
| <b>Waterbody or site description</b> (example - Fish Creek near HWY 34 crossing): |

From the list below, please check activities known to exist that you are concerned may be contributing to surface water quality impairment. Please score items you check based on distance to or occurrence on or near the waterbody of concern.

- (1 = Low occurrence or not near waterbody)  
 (3 = Moderate occurrence or within ½ mile of waterbody)  
 (5 = High occurrence or right next to water body)

| ✓                        | ACTIVITY                             | Score |   |   |
|--------------------------|--------------------------------------|-------|---|---|
| <input type="checkbox"/> | Feedlots                             | 1     | 3 | 5 |
| <input type="checkbox"/> | Livestock Grazing                    | 1     | 3 | 5 |
| <input type="checkbox"/> | Agriculture                          | 1     | 3 | 5 |
| <input type="checkbox"/> | Flow Alterations (water withdrawal)  | 1     | 3 | 5 |
| <input type="checkbox"/> | Stream/River Modification(s)         | 1     | 3 | 5 |
| <input type="checkbox"/> | Storm Water Runoff                   | 1     | 3 | 5 |
| <input type="checkbox"/> | Drought Related                      | 1     | 3 | 5 |
| <input type="checkbox"/> | Landfill(s)                          | 1     | 3 | 5 |
| <input type="checkbox"/> | Industry/Wastewater Treatment Plant  | 1     | 3 | 5 |
| <input type="checkbox"/> | Inappropriate Waste Disposal         | 1     | 3 | 5 |
| <input type="checkbox"/> | Improperly maintained Septic Systems | 1     | 3 | 5 |
| <input type="checkbox"/> | Waste from Pets                      | 1     | 3 | 5 |

| ✓                        | ACTIVITY                                   | Score |   |   |
|--------------------------|--|-------|---|---|
| <input type="checkbox"/> | Pavement and Other Impervious Surfaces     | 1     | 3 | 5 |
| <input type="checkbox"/> | Roads/Bridges/Culverts                     | 1     | 3 | 5 |
| <input type="checkbox"/> | Habitat Modification(s)                    | 1     | 3 | 5 |
| <input type="checkbox"/> | Mining/Resource Extraction                 | 1     | 3 | 5 |
| <input type="checkbox"/> | Logging/Forestry Operations                | 1     | 3 | 5 |
| <input type="checkbox"/> | Housing or Land Development                | 1     | 3 | 5 |
| <input type="checkbox"/> | Habitat Modification                       | 1     | 3 | 5 |
| <input type="checkbox"/> | Waterfowl                                  | 1     | 3 | 5 |
| <input type="checkbox"/> | Wildlife other than Waterfowl              | 1     | 3 | 5 |
| <input type="checkbox"/> | Recreational Use                           | 1     | 3 | 5 |
| <input type="checkbox"/> | Natural Sources                            | 1     | 3 | 5 |
| <input type="checkbox"/> | Other:<br><small>(please describe)</small> | 1     | 3 | 5 |

Comments/additional information:

*Revised 02Aug12*

**Figure A2.**

**Probable Source Identification Sheet for the Public**

### Probable Source(s) & Site Condition Class Field Form

|   |                                      |   |   |   |   |  |  |                     |  |  |                     |   |   |   |  |   |
|---|--------------------------------------|---|---|---|---|--|--|---------------------|--|--|---------------------|---|---|---|--|---|
| Station ID:   | Station Name/Description:            |   |   |   |   |  |  |                     |  |  |                     |   |   |   |  |   |
| AU ID:  | AU Description:                      |   |   |   |   |  |  |                     |  |  |                     |   |   |   |  |   |
| Field Crew:   | Comments:                            |   |   |   |   |  |  |                     |  |  |                     |   |   |   |  |   |
| Date:   | Watershed protection staff reviewer: |   |   |   |   |  |  |                     |  |  | Date of WPS review: |   |   |   |  |   |
| Score the proximity, intensity and/or certainty of occurrence of the following activities in the AU upstream of the site. Consult with the appropriate staff at NMED and other agencies to score "*" cells if needed. |                                      |   |   |   |   |  |  |                     |  |  |                     |   |   |   |  |   |
| <b>Activity Checklist</b>   |                                      |   |   |   |   |  |  |                     |  |  |                     |   |   |   |  |   |
| <b>Hydromodifications</b>   |                                      |   |   |   |   |  |  | <b>Silviculture</b> |  |  |                     |   |   |   |  |   |
| Channelization  | 0                                    | 1   | 3 | 5 | * Logging Ops – Active Harvesting             |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Dams/Diversion  | 0                                    | 1   | 3 | 5 | * Logging Ops – Legacy                        |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Draining/Filling Wetlands   | 0                                    | 1   | 3 | 5 | * Fire Suppression (Thinning/Chemicals)       |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Dredging  | 0                                    | 1   | 3 | 5 | Other:  |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Irrigation Return Drains  | 0                                    | 1   | 3 | 5 | <b>Rangeland</b>                              |  |  |                     |  |  |                     |   |   |   |  |   |
| Riprap/Wall/Dike/Jetty Jack -- circle   | 0                                    | 1   | 3 | 5 | Livestock Grazing or Feeding Operation        |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Flow Alteration (from Water Diversions/Dam Ops -- circle)   | 0                                    | 1   | 3 | 5 | Rangeland Grazing (dispersed)                 |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Highway/Road/Bridge Runoff  | 0                                    | 1   | 3 | 5 | Other:  |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Other:  | 0                                    | 1   | 3 | 5 | <b>Roads</b>                                  |  |  |                     |  |  |                     |   |   |   |  |   |
| <b>Habitat Modification</b>   |                                      |   |   |   | Bridges/Culverts/RR Crossings                 |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Active Exotics Removal  | 0                                    | 1   | 3 | 5 | Low Water Crossing                            |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Stream Channel Incision   | 0                                    | 1   | 3 | 5 | Paved Roads                                   |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Mass Wasting  | 0                                    | 1   | 3 | 5 | Gravel or Dirt Roads                          |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Active Restoration  | 0                                    | 1   | 3 | 5 | <b>Agriculture</b>                            |  |  |                     |  |  |                     |   |   |   |  |   |
| Other:  | 0                                    | 1   | 3 | 5 | Crop Production (Cropland or Dry Land)        |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| <b>Industrial/ Municipal</b>  |                                      |   |   |   | Irrigated Crop Production (Irrigation Equip)  |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Storm Water Runoff due to Construction  | 0                                    | 1   | 3 | 5 | * Permitted CAFOs                             |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Landfill  | 0                                    | 1   | 3 | 5 | * Permitted Aquaculture                       |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| On-Site Treatment Systems (Septic, etc.)  | 0                                    | 1   | 3 | 5 | Other:  |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Pavement/Impervious Surfaces  | 0                                    | 1   | 3 | 5 | <b>Miscellaneous</b>                          |  |  |                     |  |  |                     |   |   |   |  |   |
| Inappropriate Waste Disposal  | 0                                    | 1   | 3 | 5 | Angling Pressure                              |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Residences/Buildings  | 0                                    | 1   | 3 | 5 | Dumping/Garbage/Trash/Litter                  |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Site Clearance (Land Development)   | 0                                    | 1   | 3 | 5 | Exotic Species (describe in comments)         |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Urban Runoff/Storm Sewers   | 0                                    | 1   | 3 | 5 | Hiking Trails                                 |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Power Plants  | 0                                    | 1   | 3 | 5 | Campgrounds (Dispersed/Defined -- circle)     |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| * Industrial Storm Water Discharge (permitted)  | 0                                    | 1   | 3 | 5 | Surface Films/Odors                           |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| * Industrial Point Source Discharge   | 0                                    | 1   | 3 | 5 | Pesticide Application (Algaecide/Insecticide) |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| * Municipal Point Source Discharge  | 0                                    | 1   | 3 | 5 | Waste From Pets (high concentration)          |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| * RCRA/Superfund Site   | 0                                    | 1   | 3 | 5 | * Fish Stocking                               |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Other:  | 0                                    | 1   | 3 | 5 | Other:  |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| <b>Resource Extraction</b>  |                                      |   |   |   | <b>Natural Disturbance or Occurrence</b>      |  |  |                     |  |  |                     |   |   |   |  |   |
| * Abandoned Mines (Inactive)/Tailings   | 0                                    | 1   | 3 | 5 | Waterfowl                                     |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| * Acid Mine Drainage  | 0                                    | 1   | 3 | 5 | Drought-related Impacts                       |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| * Active Mines (Placer/Potash/Other -- circle)  | 0                                    | 1   | 3 | 5 | Watershed Runoff Following Forest Fire        |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| * Oil/Gas Activities (Permitted/Legacy -- circle)   | 0                                    | 1   | 3 | 5 | Recent Bankfull or Overbank Flows             |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| * Active Mine Reclamation   | 0                                    | 1   | 3 | 5 | Wildlife other than Waterfowl                 |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| Other:  | 0                                    | 1   | 3 | 5 | Other Natural Sources (describe in comments)  |  |  |                     |  |  | 0                   | 1 | 3 | 5 |  |   |
| <b>Legend – Proximity Score</b>   |                                      |   |   |   |   |  |  |                     |  |  |                     |   |   |   |  |   |
| Activity not known occur within AU upstream of station (includes unknown)   | 0                                    | Activity observed or known to be present near station (1 km or less) or is known to occur in moderate frequency/intensity within the AU upstream of station |   |   |   |  |  |                     |  |  |                     |   |   |   |  | 3 |
| Activity observed or known to be present but not near the station and at low frequency/intensity within AU upstream of station  | 1                                    | Activity observed or known to be present at station or known to occur in high frequency/intensity within the AU upstream of station                         |   |   |   |  |  |                     |  |  |                     |   |   |   |  | 5 |

**Figure A3. Probable Source & Site Condition Field Sheet for SWQB Staff**

**APPENDIX B**  
SSTEMP INPUT DATA AND SENSITIVITY ANALYSIS

## B 1.0 INTRODUCTION

This appendix provides site-specific hydrology, geometry, and meteorological data for input into the Stream Segment Temperature (SSTEMP) Model (Bartholow, 2002). Hydrology variables include segment inflow, inflow temperature, segment outflow, and accretion temperature. Geometry variables are latitude, segment length, upstream and downstream elevation, Width's A-term, Width's B-term, and Manning's n. Meteorological inputs to SSTEMP Model include maximum air temperature, air temperature, relative humidity, windspeed, ground temperature, thermal gradient, possible sun, dust coefficient, ground reflectivity, and solar radiation. In the following sections, these parameters are discussed in detail for each assessment unit to be modeled using SSTEMP Model. The assessment units were modeled on the date of the maximum recorded water temperature on the respective thermograph records. The assessment units and modeled dates are defined as follows:

**Table B.1 Modeled Dates**

| Assessment Unit  | Modeled date |
|--|--------------|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    | 6/30/14      |
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 7/20/10      |

## B 2.0 HYDROLOGY

### B 2.1 Segment Inflow and Outflow

This parameter is the streamflow at the top or bottom of the stream segment. To be conservative, the lowest four-consecutive-day discharge that has a recurrence interval of three years, but that does not necessarily occur every three years (4Q3), was used instead of the mean daily flow. These critical low flows were used to reflect the decreased assimilative capacity of the stream to absorb and disperse solar energy. For the upper Galisteo Creek assessment unit, where perennial flow begins at a series of seeps or springs near the confluence with Deer Creek, the flow was entered into SSTEMP Model as 0.1 cfs, which is the same flow modelled as the 4Q3 outflow. The 4Q3 was determined for both Assessment Units using the US Geological Survey's online tool StreamStats, Version 3.0 ([https://water.usgs.gov/osw/streamstats/new\\_mexico.html](https://water.usgs.gov/osw/streamstats/new_mexico.html)), and Basins, an in-house GIS application.

**Table B.2 Critical Inflow and Outflow**

| Assessment Unit  | 4Q3 Inflow | 4Q3 Outflow |
|--|------------|-------------|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    | 0.1        | 0.1         |
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 0.1        | 0.35        |

### B 2.2 Inflow Temperature

This parameter represents the mean daily water temperature at the top of the segment. For upper assessment unit, in which perennial flow begins at a series of seeps or springs, the inflow temperature was entered into SSTEMP Model as the groundwater, or accretion, temperature (see below). The mean temperature recorded on the modelled date by the thermograph deployed in 2014 at Canoncito (19.4 °C) was used as the inflow temperature for the lower Assessment Unit.

**Table B.3 Inflow Temperature**

| Assessment Unit | Inflow Temperature (°C) |
|-----------------|-------------------------|
|-----------------|-------------------------|

|  |      |
|--|------|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    | 9.4  |
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 19.4 |

## B 2.4 Accretion Temperature

The temperature of the lateral inflow, barring tributaries, generally should be the same as groundwater temperature. In turn, groundwater temperature may be approximated by the mean annual air temperature. Mean annual air temperatures for 2010 and 2014, obtained from the PRISM database (<http://www.prism.oregonstate.edu/>), were used in the absence of measured data. The following table presents the mean annual air temperature for each assessment unit:

**Table B.4 Mean Annual Air Temperature as an Estimate for Accretion Temperature**

| Assessment Unit  | Mean Annual Air Temperature (°C) |
|--|----------------------------------|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    | 9.4                              |
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 10.9                             |

## B 3.0 GEOMETRY

### B 3.1 Latitude

Latitude refers to the position of the stream segment on the earth's surface. Latitude was obtained from the SWQB Mapper, a GIS application, by taking the average between the highest and lowest values for the stream corridor within each AU. Only the continuous perennial portion of the headwaters AU (below Deer Creek) was modelled. Latitude input values are summarized below:

**Table B.5 Average Latitude**

| Assessment Unit  | Latitude (decimal degrees) |
|--|----------------------------|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    | 35.538                     |
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 35.444                     |

### B 3.2 Dam at Head of Segment

Neither of the assessment units have a dam at the upstream end of the segment.

### B 3.3 Segment Length

Only the continuous perennial portion of the headwaters AU (below Deer Creek) was modelled. Segment length was obtained from the SWQB Mapper, a GIS application (<https://gis.web.env.nm.gov/SWQB/>). The segment lengths are as follows:

**Table B.6 Modelled Channel Length**

| Assessment Unit | Length (mi) |
|-----------------|-------------|
|-----------------|-------------|

|  |      |
|--|------|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    | 3.6  |
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 33.5 |

### B 3.4 Upstream and Downstream Elevation

The following upstream and downstream elevations were determined using a USGS topographic map layer:

**Table B.7 Upstream and Downstream Elevation**

| Assessment Unit  | Upstream Elevation (m) | Downstream Elevation (m) |
|--|------------------------|--------------------------|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    | 2175                   | 2042                     |
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 2042                   | 1700                     |

### B 3.6 Width's A and Width's B Term

Width versus flow regression analyses were prepared by entering bankfull cross-section field data into a Windows-Based Stream Channel Cross-Section Analysis (WINXSPRO 3.0) Program (USDA, 2005). Field measurements were collected following the SWQB Standard Operating Procedure for Physical Habitat Measurements. Width's B Term was calculated as the slope of the regression of the natural log of width and the natural log of flow. Theoretically, the Width's A Term is the untransformed Y-intercept. However, because the width versus discharge relationship tends to break down at very low flows, the Width's B Term was first calculated as the slope, and Width's A Term was estimated by solving for the following equation:

$$W = A \times Q^B$$

Where,

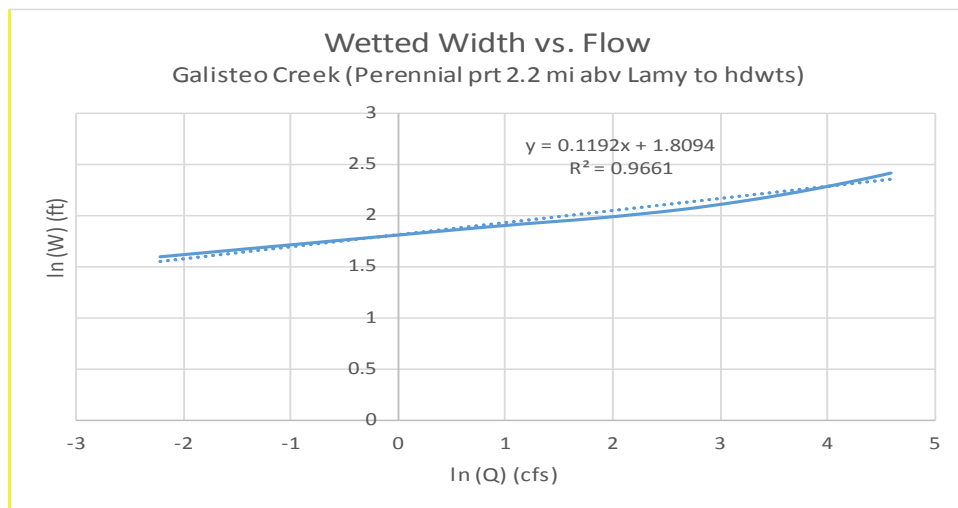
- W = Known width (feet)
- A = Width's A Term (seconds per square foot)
- Q = Known discharge (cfs)
- B = Width's B Term (unitless)

The following table summarizes Width's A and B Terms for assessment units requiring temperature TMDLs:

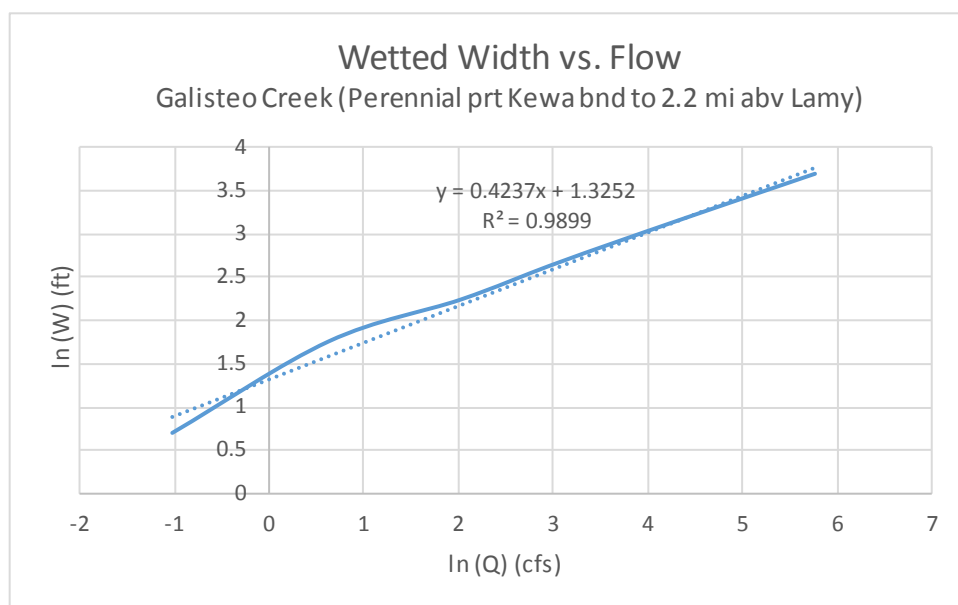
**Table B.8 Width's A and B Terms**

| Assessment Unit  | Width's A Term (s/ft <sup>2</sup> ) | Width's B Term (dimensionless) |
|--|-------------------------------------|--------------------------------|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    | 6.46                                | 0.119                          |
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 3.10                                | 0.424                          |

The following figure presents the detailed calculations for the Width's B-Term at the Canonicito and Cerrillos monitoring stations, respectively. The regression of natural log of width and natural log of flow is as follows:



**Figure B1. Wetted Width versus Flow in the Lower Galisteo Creek AU**



**Figure B2. Wetted Width versus Flow in the Upper Galisteo Creek AU**

### B 3.7 Manning's n or Travel Time

Site-specific values were generated by the WINXSPRO program described above. Manning's n is a measure of channel roughness which varies with depth of flow, increasing in value at shallower stages. The Manning's n coefficient associated with the 4Q3 flow being modelled was selected.

The following table summarizes the Manning's n input values for each assessment unit:

**Table B.9 Manning's n values**

| Assessment Unit  | Manning's n (dimensionless) |
|--|-----------------------------|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    | 0.86                        |
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 0.03                        |

## B 4.0 METEOROLOGICAL PARAMETERS

### B 4.1 Air Temperature

Air temperature is usually the single most important factor in determining mean daily water temperatures. In the absence of measured air temperature at the thermograph stations, 24 hour mean temperature on the modelled date at the nearest available weather station was obtained from the Weather Underground website (<https://www.wunderground.com/>).

**Table B.10 Mean Daily Air Temperature**

| Assessment Unit  | Mean Air Temperature (°C)* |
|--|----------------------------|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    | 26.7                       |
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 28.3                       |

\* weather station at Santa Fe Airport

### B 4.2 Maximum Air Temperature

The maximum daily air temperature in SSTEMP overrides a calculated value only if the check box is checked. Since the WQS standard of concern is the  $T_{MAX}$ , which is particularly sensitive to the maximum air temperature (Bartholow, 2002), an empirical value was entered in this field. In the absence of measured air temperature at the thermograph stations, maximum temperature on the modelled date at the nearest available weather station was obtained from the Weather Underground website.

**Table B.11 Maximum Daily Air Temperature**

| Assessment Unit  | Maximum Air Temperature (°C)* |
|--|-------------------------------|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    | 36.7                          |
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 37.2                          |

\* weather station at Santa Fe Airport

### B 4.3 Relative Humidity

In the absence of measured data at the thermograph stations, 24 hour mean relative humidity on the modelled date at the nearest available weather station was obtained from the Weather Underground website.

**Table B.12 Mean Daily Relative Humidity**

| Assessment Unit   | Mean Relative Humidity (%)* |
|---|-----------------------------|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts) | 15                          |

|  |    |
|--|----|
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 37 |
|--|----|

\* weather station at Santa Fe Airport

#### B 4.4 Wind Speed

In the absence of measured data at the thermograph stations, 24 hour mean wind speed on the modelled date at the nearest available weather station was obtained from the Weather Underground website.

**Table B.13 Mean Daily Wind Speed**

| Assessment Unit  | Mean Daily Wind Speed<br>(mph) |
|--|--------------------------------|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    | 9                              |
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 8                              |

\* weather station at Santa Fe Airport

#### B 4.5 Ground Temperature

Same as Accretion Temperature, above.

#### B 4.6 Thermal Gradient

The default value of 1.65 was used in the absence of measured data.

#### B 4.7 Possible Sun

Percent possible sun was obtained from the Western Regional Climate Center (<http://www.wrcc.dri.edu/htmlfiles/westcomp.sun.html#NEW MEXICO>). The nearest location with monthly possible sun data is Albuquerque. The percent possible sun is 83 for the month of June and 76 for the month of July.

#### B 4.8 Dust Coefficient

If a value is entered for solar radiation, SSTEMP Model will ignore the dust coefficient and ground reflectivity and “override” the internal calculation of solar radiation.

#### B 4.9 Ground Reflectivity

If a value is entered for solar radiation, SSTEMP Model will ignore the dust coefficient and ground reflectivity and “override” the internal calculation of solar radiation.

#### B 4.10 Solar Radiation

24 hour mean solar radiation data for the model dates were obtained from the National Oceanic and Atmospheric Administration’s Climate Reference Network (<https://www.ncdc.noaa.gov/news/national-centers-environmental-information>). The closest weather station with available daily solar radiation data is NM Los Alamos 13 W at the Valles Caldera. In the case of the lower AU, the modelled date was apparently cloudy at

the Valles Caldera, resulting in a depressed value for solar radiation, relative to nearby dates. The Valles Caldera location in the Pajarito mountains is subject to frequent thunderstorms. On the assumption that the thermograph maximum reading occurred on a sunny day, we used the solar radiation values for the day before the modelled date. Because solar radiation data were obtained from an external source of ground level radiation, the SSTEMP model assumes that about 90% of the ground-level solar radiation actually enters the water (Barholow, 2002). Thus, the recorded solar measurements were multiplied by 0.90 to calculate the solar radiation value entered into the SSTEMP Model.

**Table B.14 Mean Daily Solar Radiation**

| Assessment Unit  | Mean Solar Radiation (J/m <sup>2</sup> /s) | Mean Solar Radiation x 0.9 (J/m <sup>2</sup> /s) |
|--|--|--|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    | 348  | 313  |
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 288  | 259  |

## B 5.0 SHADE

Percent shade was estimated for the lower assessment unit using canopy measurements collected on October 28, 2016. Spherical densiometer readings were taken along a representative transect of the reach, using the protocol described in the SWQB Physical Habitat SOP (NMED/SWQB, 2016). The value in Table C.15 is the average of 6 measurements taken at 5 cross-sections (total of 30 measurements). The estimate of total shade used in the model calibration for the lower AU was based on spherical densitometer readings and confirmed to be representative by examination of aerial photographs. Total shade for the upper AU was 53% as measured in the field; however, examination of aerial photographs showed that number to be unrepresentative of the entire AU. An estimate of vegetative canopy was instead generated using the USDA NorWest Stream Temperature website (<https://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html>).

**Table B.15 Percent Shade**

| Assessment Unit  | Percent Shade |
|--|---------------|
| Galisteo Creek (Perennial prt 2.2 mi abv Lamy to hdwts)    | 8             |
| Galisteo Creek (Perennial prt Kewa bnd to 2.2 mi abv Lamy) | 2.4           |

## B 7.0 SENSITIVITY ANALYSIS

Sensitivity for maximum temperature values (10% variation) SSTEMP (2.0.8)  
Original maximum temperature = 27.25°C

| Variable                                 | Temperature change (°C)<br>if variable is: |             | Relative Sensitivity |
|--|--|-------------|----------------------|
|  | Decreased                                  | Increased   |                      |
| Segment Inflow (cfs)                     | +0.01                                      | +0.02 *     |                      |
| Inflow Temperature (°C)                  | +0.00                                      | +0.00       |                      |
| Segment Outflow (cfs)                    | +0.04                                      | -0.01 *     |                      |
| Accretion Temp. (°C)                     | +0.00                                      | +0.00       |                      |
| Width's A Term (s/ft <sup>2</sup> )      | -0.02                                      | +0.02 *     |                      |
| B Term where $W = A*Q**B$                | +0.01                                      | -0.01       |                      |
| Manning's n                              | +0.02                                      | -0.02 *     |                      |
| Air Temperature (°C)                     | -0.39                                      | +0.35 ***** |                      |
| Relative Humidity (%)                    | -0.23                                      | +0.23 ***** |                      |
| Wind Speed (mph)                         | +0.46                                      | -0.50 ***** |                      |
| Ground Temperature (°C)                  | -0.03                                      | +0.03 *     |                      |
| Thermal gradient (j/m <sup>2</sup> /s/C) | +0.06                                      | -0.06 **    |                      |
| Possible Sun (%)                         | +0.08                                      | -0.09 ***   |                      |
| Solar Radiation (j/m <sup>2</sup> /s)    | -0.98                                      | +1.02 ***** |                      |
| Total Shade (%)                          | +0.07                                      | -0.07 **    |                      |
| Maximum Air Temp (°C)                    | -0.95                                      | +0.97 ***** |                      |

**Figure B.3 SSTEMP Maximum Temperature Sensitivity Analysis for the Upper Galisteo Creek AU.**

Sensitivity for maximum temperature values (10% variation) SSTEMP (2.0.8)  
Original maximum temperature = 30.33°C

| Variable                                 | Temperature change (°C)<br>if variable is: |             | Relative Sensitivity |
|--|--|-------------|----------------------|
|  | Decreased                                  | Increased   |                      |
| Segment Inflow (cfs)                     | -0.01                                      | +0.01       |                      |
| Inflow Temperature (°C)                  | 0.00                                       | +0.00       |                      |
| Segment Outflow (cfs)                    | +0.02                                      | -0.02 *     |                      |
| Accretion Temp. (°C)                     | -0.01                                      | +0.01       |                      |
| Width's A Term (s/ft <sup>2</sup> )      | -0.02                                      | +0.02 *     |                      |
| B Term where $W = A*Q**B$                | +0.01                                      | -0.01       |                      |
| Manning's n                              | +0.01                                      | -0.01       |                      |
| Air Temperature (°C)                     | -0.83                                      | +0.74 ***** |                      |
| Relative Humidity (%)                    | -0.47                                      | +0.49 ***** |                      |
| Wind Speed (mph)                         | +0.37                                      | -0.40 ***** |                      |
| Ground Temperature (°C)                  | -0.03                                      | +0.03 *     |                      |
| Thermal gradient (j/m <sup>2</sup> /s/C) | +0.06                                      | -0.06 **    |                      |
| Possible Sun (%)                         | +0.09                                      | -0.09 ***   |                      |
| Solar Radiation (j/m <sup>2</sup> /s)    | -0.81                                      | +0.84 ***** |                      |
| Total Shade (%)                          | +0.02                                      | -0.02 *     |                      |
| Maximum Air Temp (°C)                    | -0.94                                      | +0.97 ***** |                      |

**Figure B.4 SSTEMP Maximum Temperature Sensitivity Analysis for the Lower Galisteo Creek AU.**

## B 6.0 REFERENCES

- Bartholow, J.M. 2002. SSTEMP for Windows: The Stream Segment Temperature Model (Version 2.0). U.S. Geological Survey computer model and documentation. Available on the internet at <http://www.fort.usgs.gov>. Revised August 2002.
- New Mexico Environment Department/Surface Water Quality Bureau (NMED/SWQB). 2016. *State of New Mexico Standard Operating Procedures*. Available on the internet at <http://www.nmenv.state.nm.us/swqb/SOP/>.

U.S. Department of Agriculture (USDA). 2005. WinXSPRO 3.0. A Channel Cross Section Analyzer. WEST Consultants Inc. San Diego, CA & Utah State University.

## **APPENDIX C**

### **RESPONSE TO COMMENTS**

New Mexico Environment Department's Surface Water Quality Bureau

Rachel,

I live along the Galisteo River and would like to submit comments on a substantial environmental problem for the TMDL public comment period.

In the early 1900's Grubnau Chemical Company built a lead/zinc floatation plant 2 miles west of Cerrillos along the Galisteo River. It is between the river and CR 57, 1/2 mile west of Waldo on the N side of Galisteo creek. You can see it from the road. It is the worst spot along the river. Nothing grows there and all the waste is washing into the river. It needs to be cleaned up. I can show you the spot anytime. Send me an email or give me a call 438-3008. I think you should see it.

Google provided this site & its link to Grubnau.

[http://environment.netonline.com/state/NM/county/santa\\_fe/npdes/](http://environment.netonline.com/state/NM/county/santa_fe/npdes/)

<http://environment.netonline.com/site.php?eid=110028120726&stid=33&ctid=1819>

Todd Brown

Cerrillos, NM

**NMED Response:** *Thank you for your comment and information regarding the Grubnau site. The data used to determine the temperature impairment and establish the TMDL were collected upstream of the former ore processing site. However, a lack of riparian vegetation and increased erosion and sedimentation into Galisteo Creek from the site would have the potential to increase temperatures in the creek and further exacerbate the impairment. In response to your comment, we have conducted a review of regulatory status, summarized below.*

*The NMED Groundwater Quality Bureau's Superfund Oversight Section prepared a Preliminary Assessment Report dated April 2007 on the Grubnau Chemical Company site, also known as the Waldo Zinc Smelter (Comprehensive Environmental Response, Compensation, and Liability Information System or CERCLIS #NM0000605582). Among other things, the assessment included collection and analysis of surface water samples upstream and downstream of the flotation plant. Some dissolved metal concentrations were higher downstream than upstream of the site in samples collected on 3/22/2004. However, the downstream data collected on 3/22/2004 and 11/1/2006 did not exceed current numeric Water Quality Standards. NMED Surface Water Quality Bureau (SWQB) does not have a monitoring station on Galisteo Creek downstream of the Grubnau site; therefore more recent data do not exist.*

*The Grubnau site does not qualify for the National Priorities List and is currently designated as archived, meaning it has no further interest under the Federal Superfund Program based on available information (see <https://cumulis.epa.gov/supercpad/cursites/srchsites.cfm>). SWQB staff conducted a National Pollutant Discharge Elimination System (NPDES) industrial stormwater Compliance Evaluation Inspection (CEI) in October 2006. The NPDES CEI report dated 11/8/2006 was sent to the property owner at the time and USEPA Region 6 in Dallas, Texas. Based on SWQB's records, USEPA issued an Administrative Order for the site in August of 2007 (NMU0001529, CWA-6-2007-1893, 8/6/2007). An on-line query of USEPA's ECHO database in*

*April of 2017 indicated that the facility does not have coverage under the NPDES Industrial Stormwater Multi-Sector General Permit. The site remains unpermitted under the Clean Water Act and NPDES, which is administered by USEPA. More detailed information about NPDES permitting is provided in Section 2.5 of the TMDL report.*

Dear Rachel,

I am sending this in accordance with your call for comments during the 'public comment' period ending in a few weeks.

I have been active over the years in helping to solidify and retain the high quality cold water classification of the stretch of the Galisteo Creek beginning at the upper watershed and going to the point 2.2 miles above Lamy.

I have sent you letters some years ago (2012) which expound on this subject and I am hoping it is already part of the public record. I include links and files of this information and my feelings about this; to you today, just to be sure it is still recorded as my "comments".

The link to my blog (which includes, also, links to photos, etc.) and this letter, attached, is there in the blog:

<http://thor-adventuretrails.blogspot.com/>

I also have sent in past thermograph air temperature readings to you all for a few years now, as I have set up a station to do that, according to the guidelines of one of your staff members a few years ago, and I am glad to send in what I can and have that (and up-to-date readings) ready for you to look at, should you be wish to do so.

Sincerely,

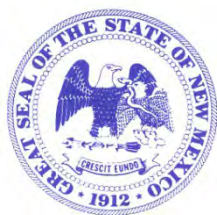
Thor Sigstedt

82 Spirit Valley

Santa Fe, NM 87508

505-466-4403

**NMED Response:** *Thank you for the information regarding the 2012 UAA and for sharing your knowledge of the watershed. This TMDL has the potential to lead to the development of a Watershed Based Plan for restoration implementation; and, subsequently, the availability of EPA non-point source restoration grants that could further our common goal in fostering a healthy watershed for Galisteo Creek.*



**DEPARTMENT OF AGRICULTURE  
STATE OF NEW MEXICO**

**MSC 3189, Box 30005  
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Telephone (575) 646-3007**

**Susana Martinez**  
Governor

**Jeff M. Witte**  
Secretary

April 27, 2017

Ms. Rachel Jankowitz, Compliance Specialist  
Monitoring, Assessments, and Standards Section  
Surface Water Quality Bureau  
New Mexico Environment Department  
1190 St. Francis Drive  
Santa Fe, NM 87505

RE: Draft Total Maximum Daily Load (TMDL) document for Galisteo Creek

Dear Ms. Jankowitz:

New Mexico Department of Agriculture (NMDA) submits the following comments regarding the Draft Total Maximum Daily Load (TMDL) document for Galisteo Creek recently published by New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB).

NMDA maintains a strategic goal to promote responsible and effective use and management of natural resources in support of agriculture. Our comments focus on the possible implications this project may have on the range livestock industry.

**Probable Sources**

Probable sources that affect the parameter of concern (temperature) for the two assessment units (AU) of Galisteo Creek are listed on tables ES-1 and ES-2. Probable sources listed include "Logging (legacy); bridges/culverts/RR crossing; low water crossing; gravel or dirt roads" for the first AU and "Highway/road/bridge runoff; stream channel incision; bridges/culverts/RR crossing; gravel or dirt roads; exotic species" for the second AU. However, Table 2.5 contains a different list of probable sources that includes livestock grazing and does not include other sources previously mentioned such as exotic species. The presence of different lists of probable sources is confusing to the reader and brings into question the methodology used to identify the probable sources.

NMDA recommends the removal of any mention of livestock grazing as a probable source unless the statement is supported by site-specific monitoring data. Statements such as, "[L]and surfaces in the watershed, and stream geomorphology, have been impacted by historic and current grazing, mining, road and railroad building activities. Land on the south side of the basin has been less impacted by excessive or improper livestock use than that on the north" (pg. 4) serve no discernable purpose in

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the context of this document. The statement is broad and forces the readers to draw their own conclusions about its meaning.

The TMDL document states that physical habitat data was “obtained on Galisteo Creek in 2016, in order to provide input variables for the SSTEMP computer model.” The document fails to indicate in what season the data was collected and the site-specific conditions of the data collection locations. This is concerning because if this data was used to form the 8 percent or 2.4 percent total shade attribute for each AU used in the Stream Segment Temperature model, the output of the model could lead to inaccurate conclusions. As noted, total shade percentage is impacted by riparian vegetation, which can have great variation depending on the time of season, drought conditions, and grazing pressure by both domestic and wild ungulates, among others. In order to obtain a true picture of how these factors impact total shade, monitoring must be conducted in such a way that a trend is established over a sufficient time period. Data collection at one point in time does not establish a sufficient trend.

Further, the results of the model that indicate the percent of total shade should increase from 8 percent to 83 percent to meet the desired reductions in solar radiation for the first AU and 2.4 percent to 29 percent for the second AU. Again, site-specific monitoring is required to determine if the two referenced stream segments have ever achieved such percentages of total shade or are capable of achieving those numbers. Additionally, the real life applicability of the results of the model are questionable because, as the document states, “adding or deleting vegetation mathematically is not the same as in real life” and “may not be practically achievable in this setting.”

Overall, the document primarily focuses on studying riparian and channel morphology disturbances as a factor of percent of total shade. The document also references rangeland grazing practices as the primary disturbance of riparian and streambank destabilization, yet it provides no monitoring data or other scientific information to substantiate that claim. It seems that rangeland grazing will be the main focus for compliance efforts pursuant to NMSA 1978 Section 74-6-10. Meanwhile, other factors such as gravel or dirt roads, abandoned mines, and impacts from the development of residences or buildings receive very little analysis and consideration within the document. NMDA requests a more thorough discussion of the possible factors impacting stream temperature be included within the TMDL document.

### **Conclusion**

NMDA appreciates the opportunity to provide comments on the Draft Total Maximum Daily Load for Galisteo Creek. We request to be kept informed of future comment opportunities such as this one. Please contact Mr. Marshal Wilson at (575) 646-4941 or [mwilson@nmda.nmsu.edu](mailto:mwilson@nmda.nmsu.edu) with questions regarding these comments.

Sincerely,

A handwritten signature in blue ink, appearing to read 'JN' followed by a stylized surname.

Jeff M. Witte

JMW/mw/ya

## **NMED Response:**

**1. Probable sources list.** The probable source data sheets filled out by SWQB field staff are designed to rank potential sources on a scale of 0, 1, 3, or 5, based on the proximity, intensity and/or certainty of occurrence of the activity in the assessment unit. Table 2.5 lists all probable sources that might affect temperature and that were ranked 3 or 5. For brevity, only those probable sources with the highest ranking of 5 were included on Tables ES-1 and ES-2 in the Public Comment Draft TMDL report. In response to your comment we have added all of the Table 2.5 probable sources to the Executive Summary tables. While exotic species was ranked as 5 on the data sheet for Assessment Unit NM-2118.A\_10, we have removed it from Table ES-2 because it is unlikely to have an adverse effect on attaining temperature standards. Thank you for bringing this to our attention.

**2. Grazing as a probable source.** While it would be ideal to have site-specific monitoring data for a number of variables, including grazing, it is beyond the available resources of the SWQB to do so. NMED does not state or imply that grazing is the primary source of temperature impacts in the watershed. As stated in Section 2.7 of the TMDL document, the probable sources list is a starting point to be refined or revised in the process of Watershed Based Plan (WBP) development, and does not single out any particular source or land owner. It is outside the scope of the TMDL to address probable sources in greater detail. The completion of a TMDL can lead to opportunities for subsequent monitoring, planning and restoration activities to address watershed conditions that contribute to the temperature impairment, through an approved WBP and application for grant funding.

The inclusion of livestock grazing on the list of probable sources is supported by a large body of peer-reviewed literature documenting adverse effects on stream habitat. Grazing is cited as one among many probable sources of impairment in the 2005 Watershed Restoration Action Strategy for the Galisteo Creek Watershed (available at <https://www.env.nm.gov/swqb/wps/WRAS/GalisteoWRAS07-01-2005.pdf>). The statement on page 4 of the TMDL report about the relative impact of grazing on different parts of the watershed was provided by a local expert on the Galisteo watershed, as cited in the document.

Regarding compliance efforts, non-point sources are addressed through voluntary actions in New Mexico. The Watershed Protection Section (WPS) of the SWQB has staff available to cooperatively educate stakeholders and implement best management practices to reduce nonpoint source pollutants from entering the surface and ground water resources of New Mexico. WPS is responsible for organizing all federal Clean Water Act (CWA) §319(h) related activities in watersheds with TMDLs and impaired waters. Workplans developed and funded under CWA §319(h) comprise a variety of efforts, including watershed association development, riparian area restoration, spill response, and treatment of abandoned mines.

**3. Shade and physical habitat.** The physical habitat data were collected on October 28, 2016, following SWQB Standard Operating Procedures ([https://www.env.nm.gov/swqb/SOP/documents/5.0\\_Physical\\_Habitat\\_SOP\\_4-11-2016.pdf](https://www.env.nm.gov/swqb/SOP/documents/5.0_Physical_Habitat_SOP_4-11-2016.pdf)). The majority of foliage was still on the branches; where leaves had apparently fallen, the space between

*branches was interpolated as positive for canopy cover. The data collection locations were at the established SWQB monitoring stations 30Galist71.2 (Spirit Valley Road 2.2 miles above Lamy) and 30Galist30.9 (at Cerrillos). The results were 53% and 2.4% shade, respectively. However, based on aerial images, 53% canopy did not appear to be representative of the entire Assessment Unit. Therefore a shade value (8%) was generated from the USDA Forest Service NorWeST temperature model database (<https://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html>).*

*As stated in the TMDL report, an increase to 83% shade is not likely achievable, and a combination of increased shade and actions affecting stream morphology will likely be needed to attain the temperature WQS for Galisteo Creek. It is possible to account for stream width using SSTEMP, however, due to the extremely low flows being modeled, the model in this case is insensitive to the width factor (as shown by the sensitivity analyses in Appendix B).*